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IRON AND STEEL ENGINEER

SEPTEMBER • 1940

VOL. XVII NO. IX

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Published Monthly by

ASSOCIATION OF IRON AND STEEL ENGINEERS

Entered as second-class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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Single Copy Foreign Prepaid $2.00 Single Copy $2.00
Subscription price in U. S. & Canada.....$ 7.50 per year
Subscription price in foreign countries.....$10.00 per year

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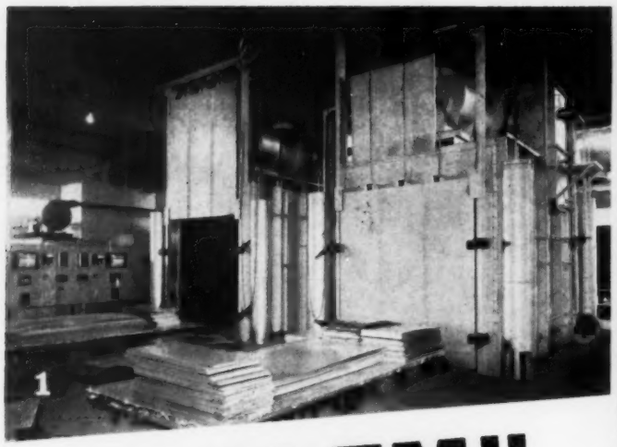

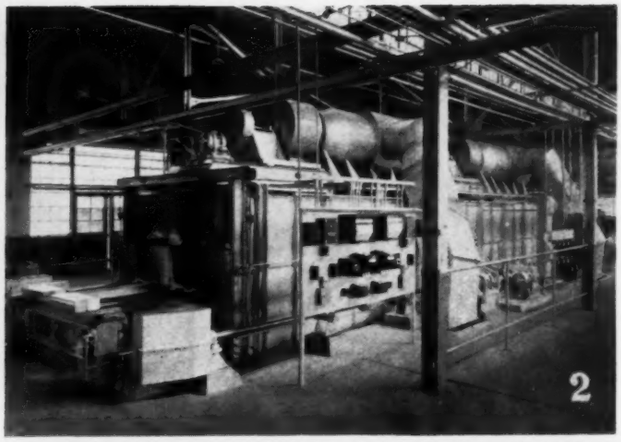

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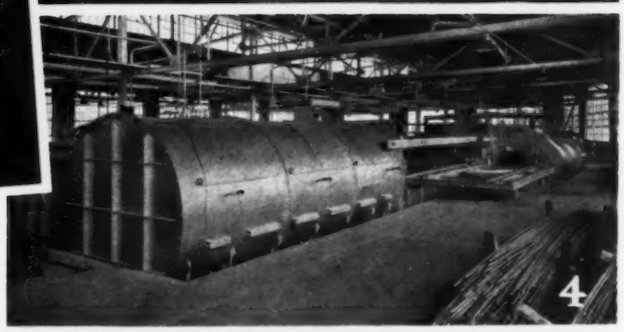

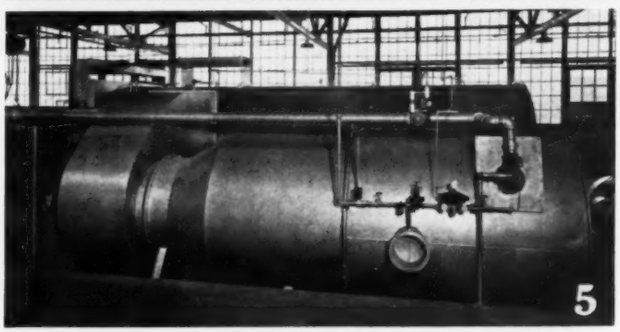

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Photo 1—Car Type Furnace for annealing aluminum sheets and plates for aircraft parts.

Photo 2—Continuous Chain Conveyor Furnace for heating aluminum billets for rolling.

Photo 3—Car Type Furnaces. Convection unit located along side furnaces.

Photo 4—Tubular Hardening Furnace including quench, fully automatic.

Photo 5—Shows the new type convection unit.

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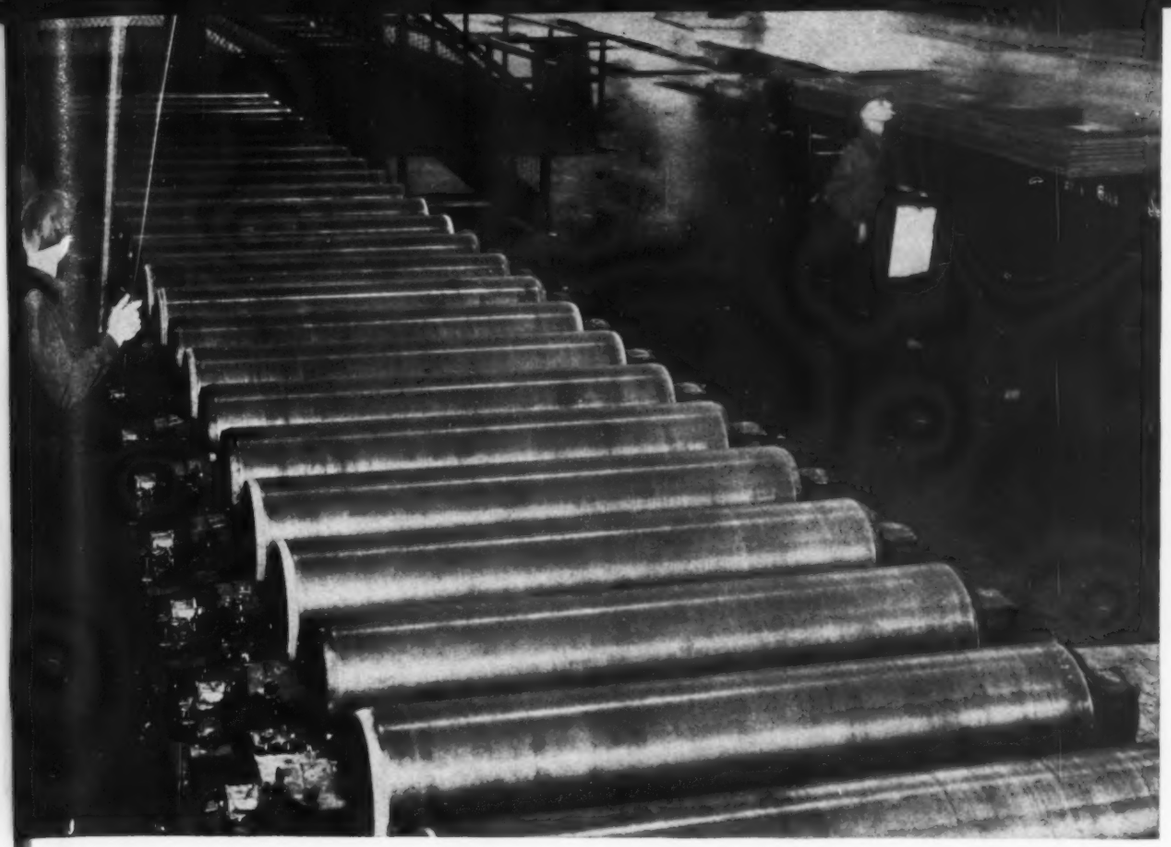

Schloemann Installations in a plate mill at Pittsburgh

Left—"Motor-Roller" equipped Scale Table

Below—
"Motor-Roller" equipped Shear Depressing Table

EXCLUSIVE ADVANTAGES *of* SCHLOEMANN "MOTOR-ROLLERS"

With the rotating trunnion-type roller housing the driving motor, the necessity for using line shafts, couplings and gear reduction units is eliminated. Simplified table construction is the result, affording free access along both sides of "Motor-Roller" Tables.

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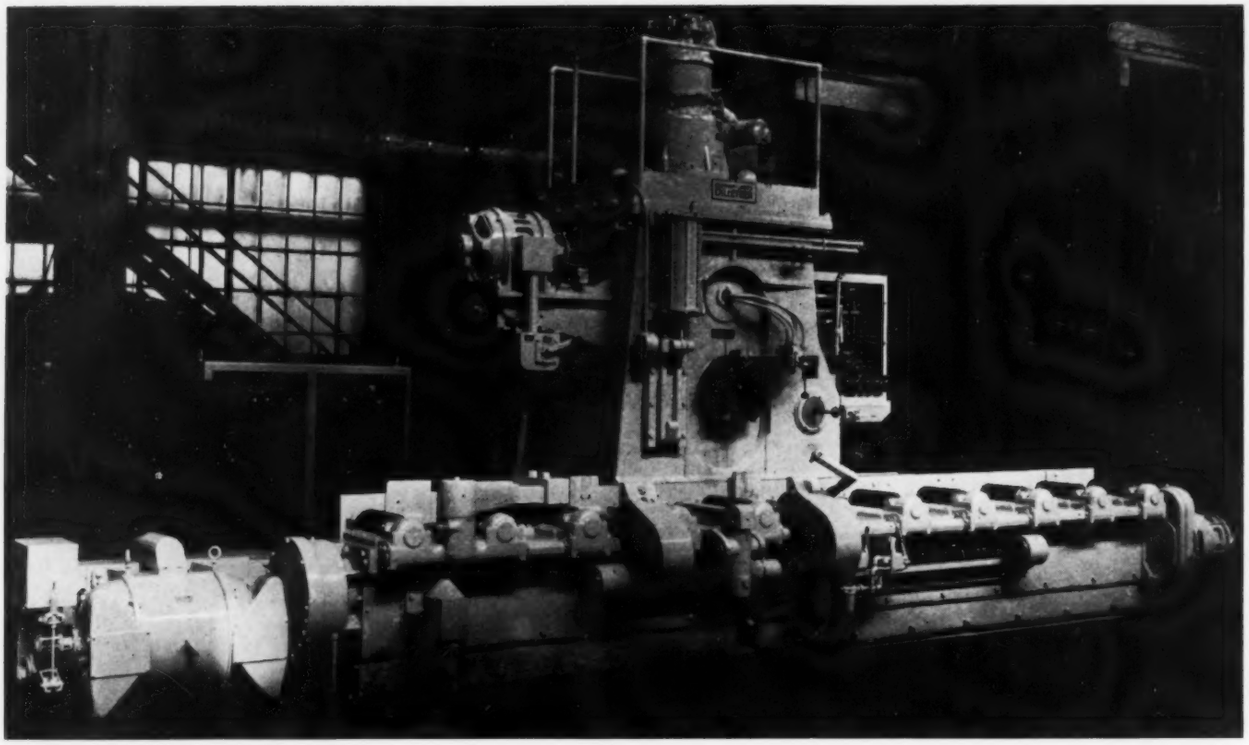

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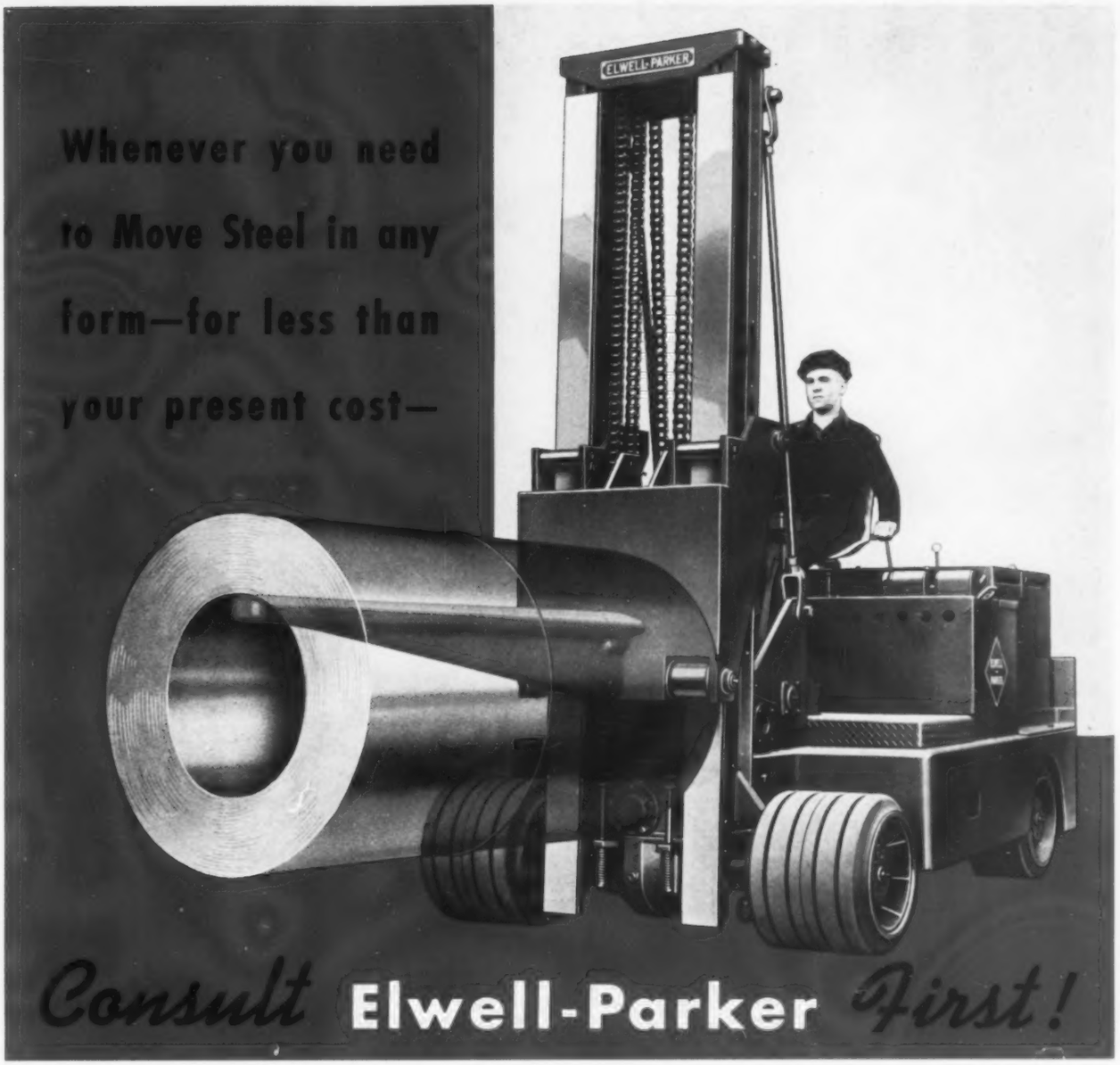

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ESTABLISHED 1893 • BUILDING POWER INDUSTRIAL TRUCKS SINCE 1906

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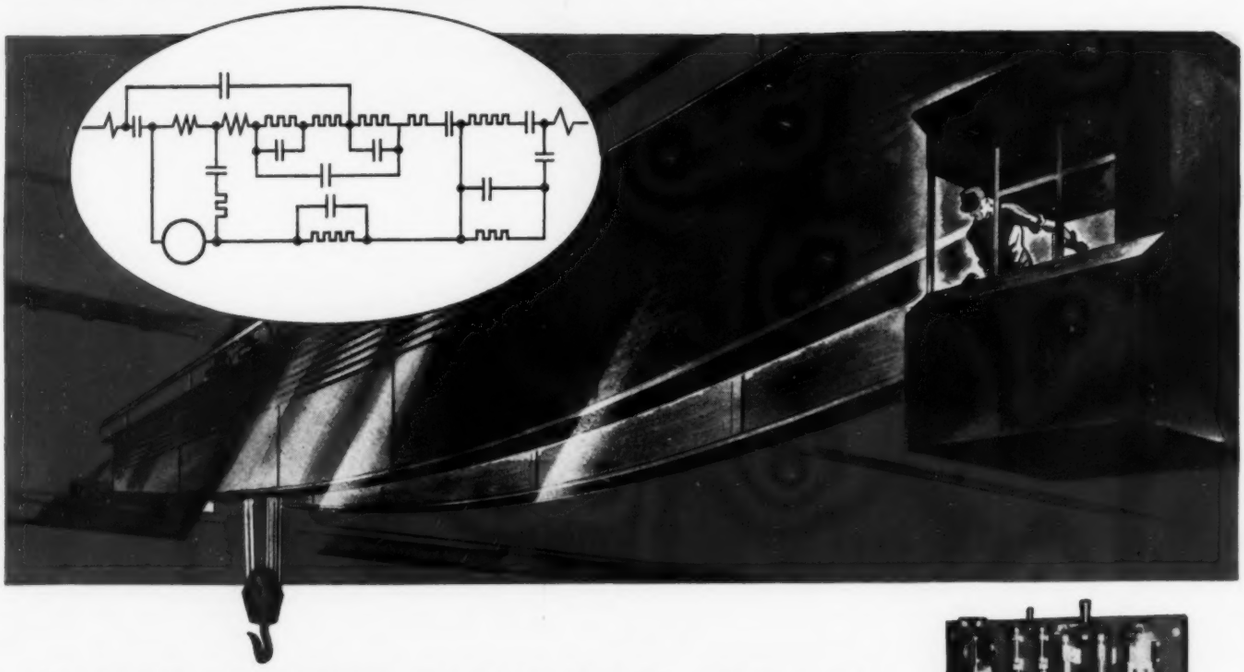

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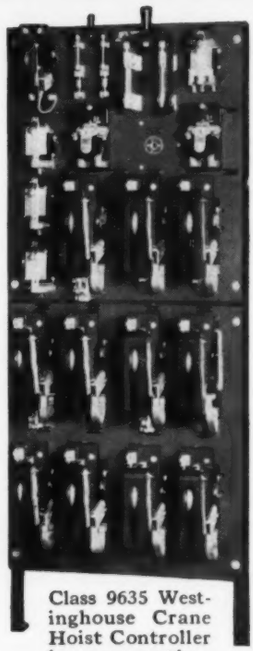

Class 9635 Westinghouse Crane Hoist Controller incorporating the new series 200 SM contactors and Type TI and TL Relays.

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This new lathe offers many new fine construction features. Chatterproof—noiseless—external face plate gear—no overhung gears or pinions—no bronze bearings or bushings—oil pressure lubricating—glass portholes to view headstock interior—face plate pinion supported at both ends and many other innovations in lathe construction. These lathes are built in any size to meet your requirements.

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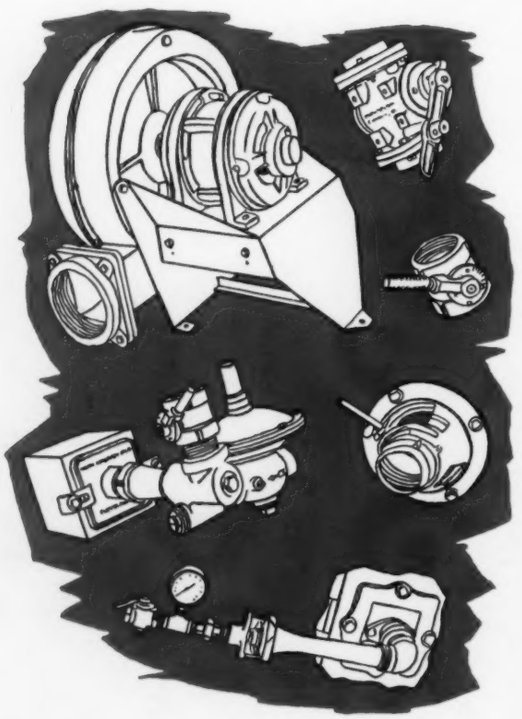

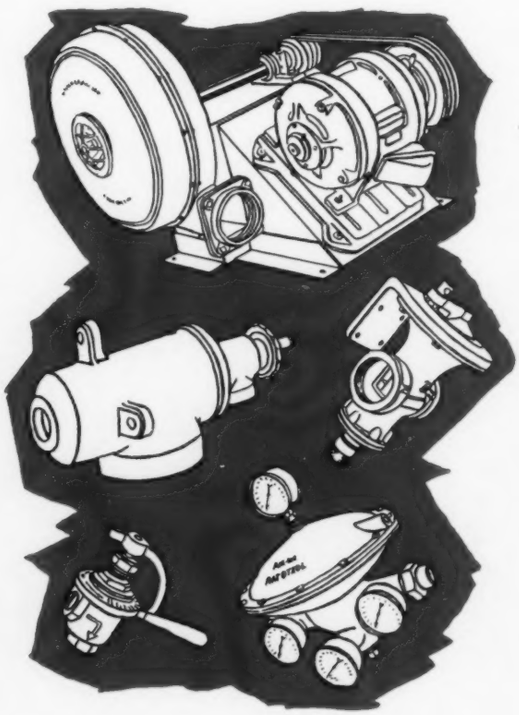

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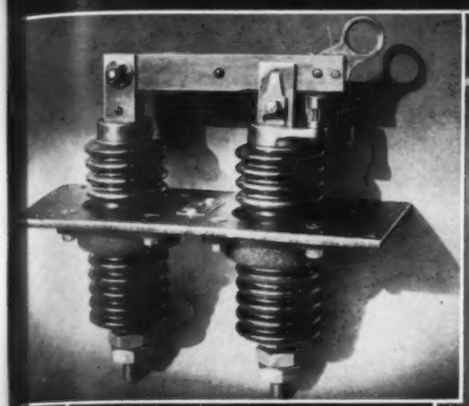
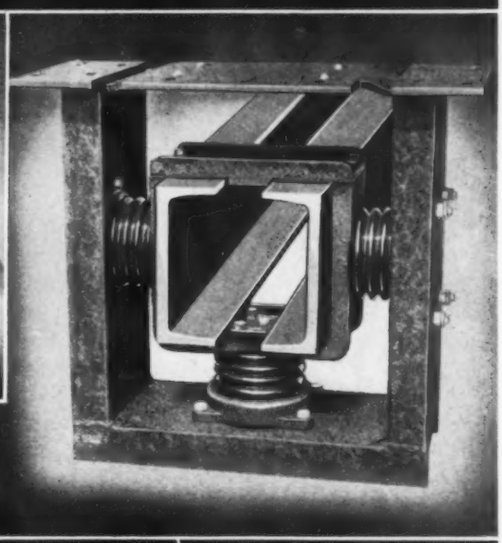


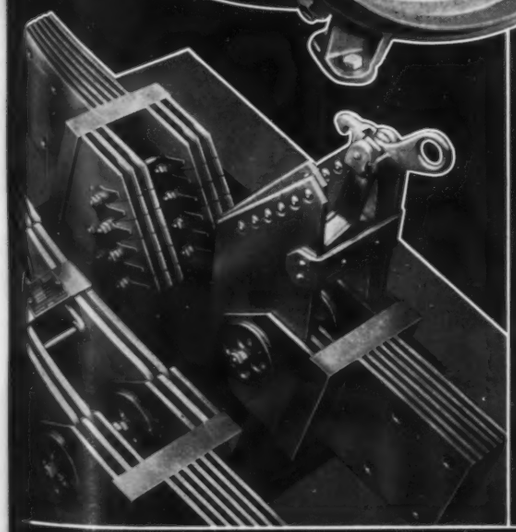


ABOVE LEFT
SINGLE POLE
BACK CONNECTED
DISCONNECTING
SWITCH.

ABOVE RIGHT
HEAVY DUTY
DOUBLE CHANNEL
BUS SUPPORT.

CENTER
ENCLOSED METAL BUS
STRUCTURE.

BELOW
HEAVY DUTY
5000A 440V
HI-PRESSURE
CONTACT
SWITCH.



for the STEEL MILL

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GREENSBURG, PA.

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A —*R & I E has many extra features. They originated many equipment features now accepted as standards of the industry. Today, the Hi-Pressure Contact and the Round type Isolated Bus are outstanding. Experience shows, too, that ALL R & I E equipment does ALL it is intended to, and more. They put sufficient intelligence and careful manufacturing into their products to insure absolute minimum maintenance and maximum reliability. You make no mistake in buying R & I E equipment.*

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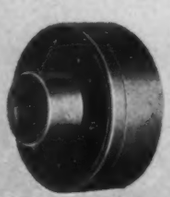
Write today for your copy of the new 6-page *Motor Price List*, which gives prices, weights and dimensions of standard motors in sizes up to 75 horsepower.



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CROCKER-WHEELER ELECTRIC MFG. CO., AMPERE, NEW JERSEY

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Products: Polyphase Induction Motors, Synchronous Motors, Direct-current Motors, Alternating-current Generators, Direct-current Generators, Motor-Generator Sets, Flexible Couplings.

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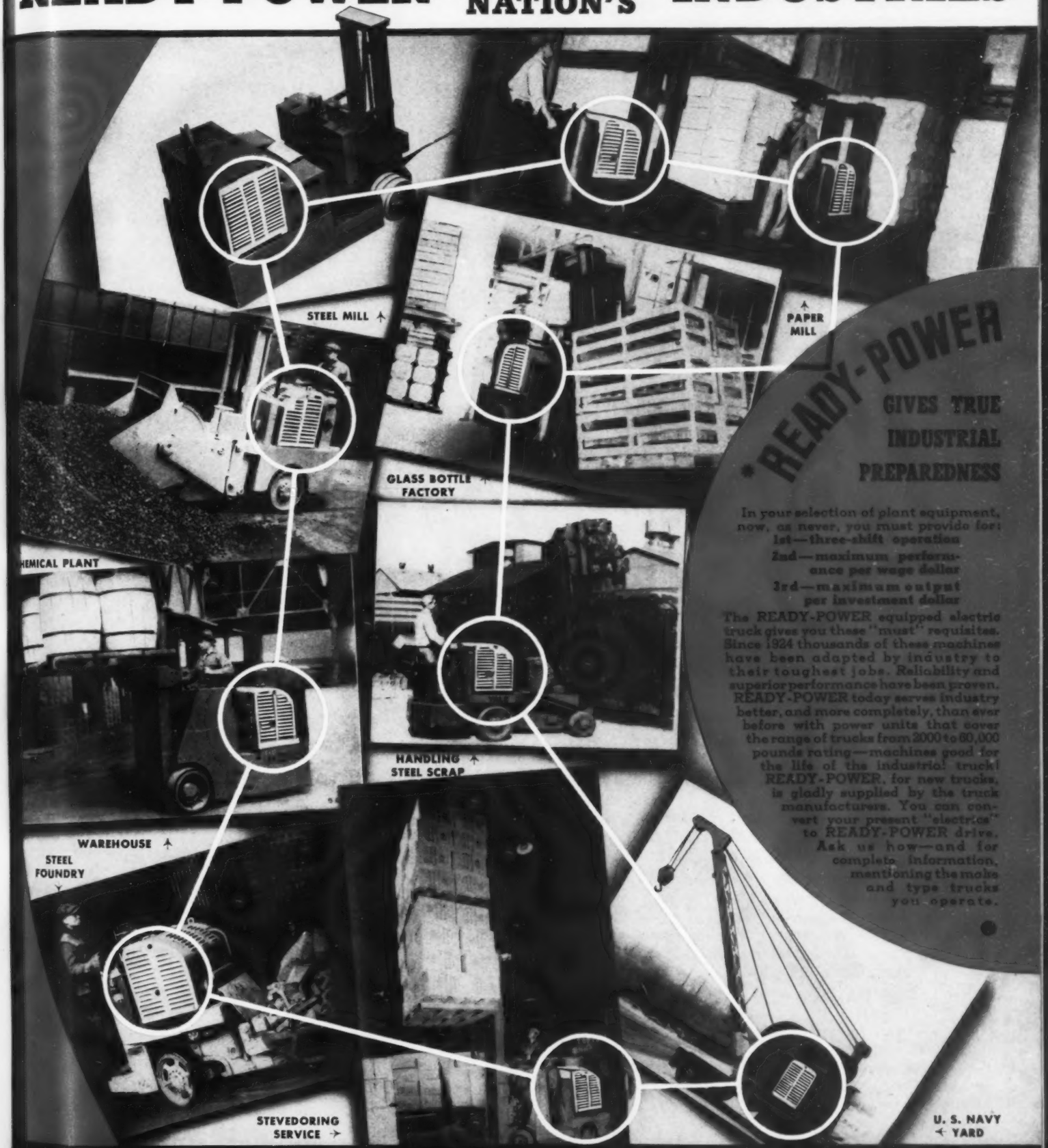

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2nd—maximum performance per wage dollar

3rd—maximum output per investment dollar

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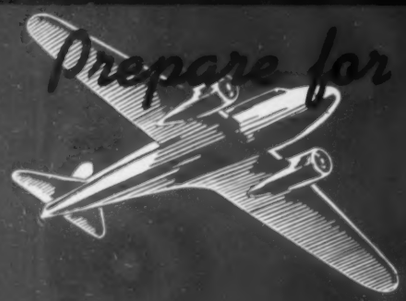


Prepare for NATIONAL DEFENSE PRODUCTION WITH ADEQUATE AND EFFICIENT MATERIALS HANDLING EQUIPMENT

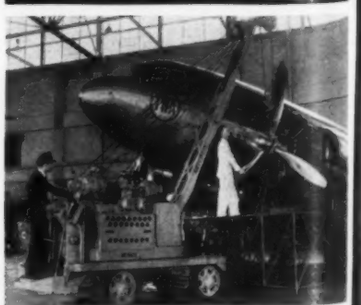
TRADE **AUTOMATIC** MARK

Whether you have already been called upon or expect to be asked to play your part in the National Defense Program it's TIMELY to check up on your materials handling system and equipment as many others have already done. It is highly important that you make sure you will have *adequate* and *efficient* equipment to *carry thru* without any bottlenecks or loss of valuable production time and skilled labor.

To get this *quick action* on Material Handling Problems get the valuable experienced aid now of the "AUTOMATIC" representative nearest you — let him show you the features of construction that today make "AUTOMATIC" "Electric Propelled" Material Handling Equipment the low-cost way for transporting, handling, stacking, piling, lifting — whether packaged goods, raw material, or bulk —see how "AUTOMATIC" offers you the greatest opportunity for speed, efficiency, and safety— learn why "AUTOMATIC" is today's economical answer to those thousand and one material handling jobs.

If it is necessary to replace your old equipment or add to your system "AUTOMATIC" has the *only* complete line of "Electric Propelled" equipment from which to recommend the type and capacity best suited to your needs. Then, too! Each "AUTOMATIC" is designed and perfected for its specific job with the latest engineering production tools to do your job reliably at lowest cost. Whether it's travel—lift or maneuvering you will have the satisfaction of knowing every movement is being performed with precision, efficiency, and utmost speed with safety. You'll know that with "AUTOMATICS" on the job your materials handling will be accomplished expertly and economically as can only be done with "Electric Propelled" equipment.

Some of the heavy duty types of the "AUTOMATIC" line are illustrated here. They represent but a part of the many "AUTOMATICS" now serving American Industry behind the scenes for the National Defense Program.



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AUTOMATIC TRANSPORTATION COMPANY

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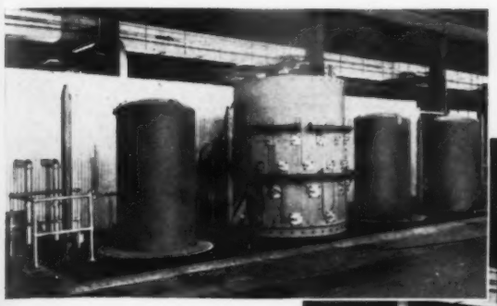
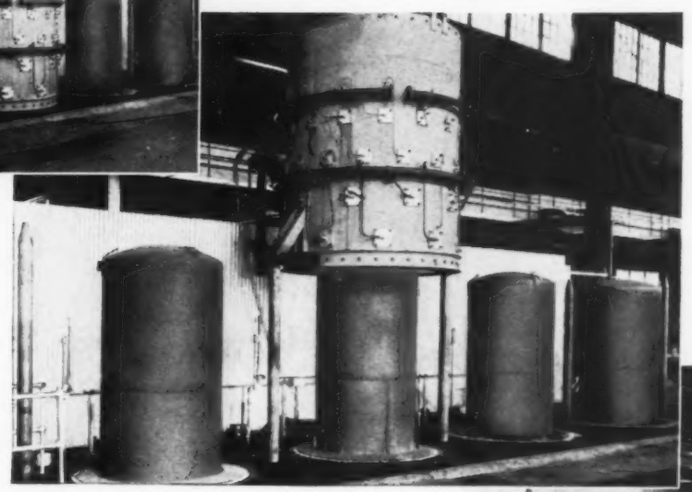
Maintain Uniform Temperature Throughout Charge

Regardless of

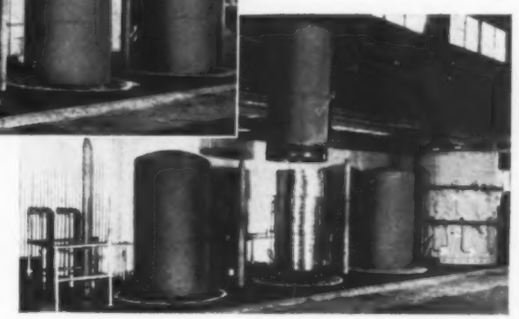
Weight, Size or Height of Load



(Above) An E. F. Hood Type Installation consisting of furnace, 4 bases, and retorts.



(Left) Each base accommodates charges up to 22,000 lbs. and coils up to 45" in diameter.



(Right) Removing a retort from base, showing bright annealed charge.

FOR ANNEALING STRIP, WIRE AND OTHER PRODUCTS

Equipped with special radiant type gas burners and separate automatic temperature control zones, these E. F. gas fired removable hood type furnaces obtain and maintain uniform temperature distribution throughout the entire charge on each and every load, regardless of weight, size or height of load.

The installation shown above was designed for annealing medium and high carbon mirror-finish cold rolled steel strip, and is equipped with special E. F. gas generator equipment for producing the protective atmosphere for bright annealing without decarburization. Each base accommodates charges up to 22,000 lbs. and handles coils in any width and up to 45" in diameter.

This installation is equipped with a pre-mix plant for mixing the gas and air in proper porportions This eliminates all manual burner adjustments, as the gas-air mixture is previously obtained in the machine. The high turn down ratio on burners permits use of modulating type control.

This equipment is provided with 4 bases, each with motor driven centrifugal type fan for circulating atmosphere down through the center of the charge and up between the outside of coil and the gas-tight retorts.

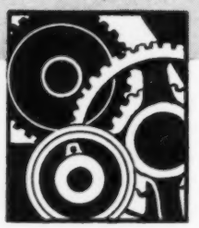
An extremely high rate of circulation is obtained and uniform temperature is provided and maintained regardless of the size of charge. Additional information on the above or on any other type furnace will be gladly furnished on request.

The above is only one of the numerous types we build for various annealing and heat treating purposes. We build Gas Fired, Oil Fired and Electric Furnaces—Furnaces for any process, product or production. Our large and experienced engineering staff and ample manufacturing facilities enable us to make reasonably prompt deliveries. We solicit your inquiries.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

Maintenance MUST BE Maintained



REGARDLESS of what your plans for construction or alteration may be, maintenance in your present plant must go on.

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Improvements in

OPEN HEARTH DESIGN *and* OPERATION

By L. F. REINARTZ

Manager, Middletown Division

AMERICAN ROLLING MILL COMPANY

MIDDLETOWN, OHIO

PRESENTED BEFORE A. I. S. E., SPRING CONFERENCE, CINCINNATI, OHIO, APRIL 1 and 2, 1940

▲ IT is true that, as far as the design of open hearth furnaces is concerned, the engineer who built the first furnace would be able to recognize the basic elements in the present steel producing furnace; however, the modern, high-powered, high-tonnage open hearth furnace is a long way ahead of its predecessors of sixty years ago. In those days furnaces tapped heats weighing 25 tons or less. They were usually hand-charged with sand cast pig iron and indifferent scrap, the fuel practice was terrible, and tons per hour were very low. Costs, as compared to present-day practice, were extremely high.

Through the efforts of operators and engineers, steady progress has been made in modernizing old open hearth shops. Engineers have profited by the work of men in these older shops and have designed and built modern open hearth plants in which 150 to 225-ton heats are tapped in record-breaking time with good cost economy and of superior quality.

This 125 ton hot metal crane was rebuilt, with all controls enclosed.

In these developments, the refractory, fuel, construction, metallurgical and industrial engineers have collaborated with the men before the furnaces, who have usually come up through the school of hard knocks, to improve quality, increase tons per hour, and reduce operating costs. These studies, and the development of long-range programs for improvements each year by progressive open hearth managements are the reasons for the phenomenal improvement in open hearth practice in recent years.

Forward-looking managements have given help to the open hearth superintendent by assigning to his department construction and fuel engineers, who spend all their time studying results obtained from operations, and then making recommendations for improvement in practice, first, and later, changes in design.

Since the mechanical engineers have plenty of latitude in designing a new open hearth shop, limited only by available funds, it would seem advisable to discuss how various engineers have helped operators improve existing conditions.

STOCKING AND CHARGING

There is a saying among open hearth operators, "You can't melt steel unless you get the charge into the furnace." Probably as much inefficiency creeps into stockyard and charging operations as in all other open hearth operations combined. The engineer, therefore, concerns himself with the observation of stocking and charging operations. If it is a cold metal shop, all his attention is first focused on the stockyard or shed as the case might be. If it is a hot metal shop, half of his attention will be given to the observation of the handling of hot metal which may take him all the way back to the blast furnace.

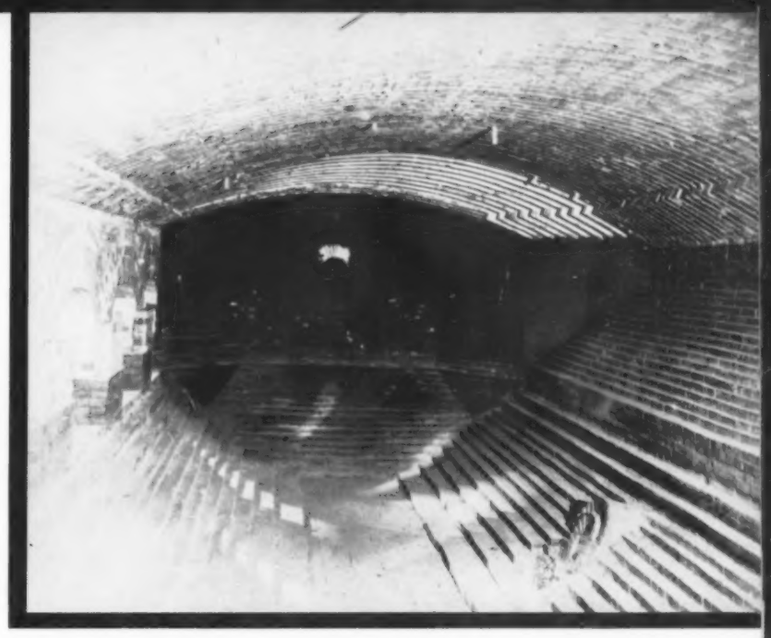
What are the essentials an engineer should insist upon for rapid charging of an open hearth furnace?

First of all, the stockyard must be sufficiently large to allow all stocking operations to be carried on efficiently. A standard gauge track should extend preferably through the middle of the yard, and should be arranged

for switching standard type cars with incoming scrap from the opposite end of the yard to the territory served by the stock engines. This avoids interferences and delays in charging. There should be at least two standard or narrow gauge tracks (depending on the system used) running through the stockyard adjacent to each other. There should be sufficient cross-over tracks under the runway to guarantee continuous operation. Practice has indicated that there should be a 10-ton overhead crane for charging every three 125 to 175-ton open hearth furnaces if an ordinary variety of scrap is charged. These cranes should be rugged and able to operate twenty-four hours a day with only one half-hour reserved for inspection each day. They should have a bridge speed of at least 400 ft. per min., and a hoist speed of 50 ft. per min. Every crane should be equipped with a 65 in. magnet to speed up operations. Electric cable connections should be so arranged that the magnets may be detached very rapidly. The magnets should be water-proofed if the stockyard runway has no roof over it.

Stocks of various grades of scrap and pig iron should be kept in separate piles on the ground available for taking care of switching delays, and temporary shortages of scrap and pig iron cars in the yard. In addition, modern quality demands make it essential that various grades of scrap should be kept separate for quality and accounting control purposes. For most efficient practice, it is best to load directly from the standard railway equipment into the charging pans on charging buggies. Charging pans may be made out of riveted, or welded plate, or more often they may be of cast steel design. In the long run, the latter will hold their shape better and last longer. Skillful welders can make such pans last indefinitely. Every effort should be made to use the highest and longest pan that charging machine and furnace door clearances will allow. A questionnaire sent out some time ago indicated that one plant was using a very large pan—32½ cu. ft. content. The pans should be carried on strongly built cast steel charging buggies. (In time welded designs may be developed.) Time will be saved, safety will be improved, and maintenance costs reduced by the installation of roller bearings and automatic couplings on charging cars. Changes of this type can often be made gradually by purchasing such equipment over a period of years. Experience has proved that where the stock shed is not an integral part of the open hearth building, it will pay dividends to install heavy (preferably 100 lb.) rails on creosoted ties and on a gravel or blast furnace slag ballasted road-bed. Oil electric locomotives have shown almost 100 per cent availability twenty-four hours a day in all kinds of weather—a very important consideration from a furnace delay standpoint.

It is desirable to have local mill scrap, particularly sheet scrap, come to the open hearth either baled or wired into compact bundles that can be placed directly into charging pans. It is helpful to have overhead ore and limestone bins in the stockyard so that these materials may be loaded by gravity. This equipment, however, is usually lacking, and stockers must load limestone and ore by hand directly from railway cars, or locomotive cranes equipped with buckets load charging pans from stock piles in the storage yard. In any event, cranemen and stockers should be trained to fill all pans to their full capacity.



View of the interior of a 150 ton open hearth furnace prior to building up the magnesite bottom.

In transferring drags of buggies to the open hearth charging floor, a spacer buggy is often interposed between the drag of buggies and the stock engine. This acts as a safety car for the switchman and can carry necessary supplies for derailment, etc. It is preferable, if possible, to eliminate all sharp curves in a stockyard track layout. Best accounting and quality results are obtained when all buggies are light weighed, and an accurate weight kept of all items composing a charge. Additions to the ladle later on are no more accurate than the accuracy of the weights charged into the furnace. To achieve such results, means good housekeeping and cleanliness around the scales, as well as a daily check of the track scales by the plant scale tester. An

Reinforced ribs are used between the buckstays of this sloping back wall, which is now universally used on open hearth furnaces.

essential feature of successful stockyard operation is the proper scheduling of scrap and pig iron cars coming into the stockyard for unloading. Better metallurgical results will be obtained in the open hearth practice if closer standardization of the percentages of various items in the charge can be achieved from heat to heat.

CHARGING FLOOR OPERATIONS

In a cold metal shop, the pig iron is, of course, hauled from the stockyard to the open hearth floor. In hot metal shops, the hot metal is transported from the blast furnaces to the open hearth department either in open top ladle cars, or by means of submarine-shaped mixer ladle cars. The former are used for short hauls from the blast furnace to the open hearth shop. The latter are used for longer hauls, such as at the American Rolling Mill Company, Middletown, Ohio, where the metal is transported from New Miami, Ohio, over the Baltimore and Ohio Railroad a distance of twelve miles. When the hot metal reaches the open hearth department, it is either poured into mixers ranging in size from 300 to 1200 or more tons, or the hot metal is used directly from the 125 to 175-ton mixer ladles. These latter ladles are less expensive to operate since no additional heat is needed, large skulls are rare occurrences, and temperature is conserved, but blast furnace practice must necessarily be more regular because there is no opportunity to mix casts. At the Middletown Plant, a double trestle scheme is under consideration so that hot metal from two ladles may be poured into a transfer ladle at one time. Transfer ladles in shops having eight or less furnaces are usually carried to the furnace by overhead cranes. These cranes should be large enough to handle the entire charge of hot metal at one time so as to conserve crane time, temperature of the metal and to speed up charging operations. In larger shops, hot metal ladles are transported to the furnaces by means of motorized transfer cars operating on standard gauge tracks behind the charging machines on the charging floors. This saves crane time and expedites charging.

There should be enough track cross-overs on the charging floor to allow furnaces to be charged with minimum interferences. In some plants, furnaces are charged from one end of the shop entirely and have a tail track at the opposite end of the shop to allow charging of the last furnace. In large shops having more than eight furnaces, it is often customary to have more than one entrance from the stockyard. The empty charging cars are taken to the stockyard from the end of the floor opposite to the incoming loaded drags.

In the United States, floor-type charging machines are preferred. They are built very ruggedly to withstand the abuse to which such a machine is subjected. Old machines in a reconstructed shop may have to be replaced if they can't do the job without serious delays. It pays to spend time to get the best design charging peel assembly. Peels which have large cooling vanes cast on the part of the spindle that enters the furnace during charging operations last longer.

For good practice in charging, refining and finishing the open hearth charge, many auxiliary aids are essential. First, for the well-being and efficient work of the furnace men, there must be a well-paved charging floor. One plant has solved the vexing problem of charging tracks being out of order and warped, due to hot metal spills and breakouts, by installing sectional steel grid castings between and under rails and fastening the rails to this grid. The holes in the grids which are about 12 in. square are then bricked up.

Bins must be provided on the charging floor in convenient locations for such items as aluminum, ferrosilicon, spiegeleisen, ferro-manganese and other alloys. They may be built out of used checker brick, or welded plate. Scales placed at frequent intervals save long hauls for the second helper. For accuracy they should be equipped with weight-o-graphs. Means should be provided, preferably inside of the open hearth building, for storage of refractories, fluor spar, rabbles, stirring rods, etc.

The refractories should be loaded, if possible, into pans by gravity and transported to the furnace by an overhead crane or on the floor by a tractor. It is helpful to provide a storage track on the floor for unloading repair supplies, brick, and open hearth operating equipment and supplies. A dolomite gun is an asset to a shop if the organization can be trained to use it properly. Misuse of this machine means high bottoms and that spells trouble in any open hearth shop. It lends itself much better to service in shops making a large percentage of low carbon steels. A patching gun is a boon to the first helper when he must repair ports, furnace corners, skewback line, and front walls. A wet mixture of fine chrome ore and some fire clay is shot by air pressure on to the place to be protected and patched.

All modern shops have magnets available for the open hearth floor cranes so as to expedite cleaning up scrap which falls from pans during charging operations. Care should be exercised in charging this scrap into the furnace for which it was intended in order not to have low recovery from such charge. Such little improvements as using rubber-tired wheelbarrows or well balanced two-wheeled steel dump buggies improve the work and morale of the worker.

In a number of plants where structural design permits, arrangements have been made to place a track under the charging floor between the air checker chambers so that a slag buggy may be placed under the middle charging door of the furnace. This buggy catches the run-off slag from high ore heats. It may also be used to catch excess slag from the tap hole after the runner has been removed and thus eliminate one more hard labor job in the open hearth department.

Many plants have preliminary test laboratories on the charging floor with chemists in attendance. Others use a 4 in. pneumatic tube system to send samples to the control laboratory and receive the record of the analysis in the same way. In recent years special analyzers, such as the carbometer, and carbanalyzer, have been developed so that the furnace man can make his own preliminary carbon tests. In several plants telautograph systems keep the blast furnace and open hearth operating men informed as to casting times, delivery of hot metal schedules, and analyses of casts. The object of all these aids to the furnace men is to reduce or eliminate delays and thus speed up bottom making, as well as charging and refining operations of the steel or iron charge.

FURNACE DESIGN

The open hearth engineers and operators have made great changes in the design of various parts of open hearth furnaces in the last ten years. A concensus of opinion indicates that the open discussion of shop problems by the national Open Hearth Committee has brought to the attention of operators many new ideas being tried out in other plants. This interchange of experiences stimulates men's minds to make further improvements.

With the exception of one plant where the new furnaces were limited in capacity due to existing furnaces, new open hearth furnaces built in the last five years have usually been able to charge 175 to 225 tons and tap the same into a single ladle. Double pour from open hearth furnaces is usually not considered desirable due to the extra cost of refractories and additional quality difficulties connected with the even flow into two ladles. This practice, with one very outstanding exception, has only been adopted where the cost of strengthening crane runways and ladle cranes in the pouring pit would be prohibitive.

Every effort has been made by progressive managements to enlarge the furnaces so as to tap more steel out of any given furnace and thus reduce operating costs. In some cases, this has meant deepening the metal bath to 40 in., but no adverse quality results have been reported because of these deeper baths. In carrying out such a program at times changes have been made in the fuels used. In the Middletown plant expansion program, an old producer plant was abandoned and, depending on the market, natural gas or heavy fuel oil substituted. This change allowed the lengthening of the hearths 3½ ft. without lengthening the furnace overall, except to eliminate the producer gas dog-house and square up the furnace ends. The chill box design was changed and the top of the box was raised 6 in. The hearth beams and bottom plates were spliced so as to widen the furnace hearth 24 in. towards the pit. Five-inch extensions were placed on all sill plates under the charging doors. The first time the furnace hearth plates were spliced, the plate extensions were bolted and riveted to the original plates in the pan on the hearth. Expansion and contraction over a period of years tore these connections apart. The next time they were riveted, splice joints butt-welded, and additional plates were welded across the spliced joints which have held together for about five years. These changes, plus insulation of the pan and a somewhat different method of installing the brick and burning in the bottom, have made it possible regularly to tap 160 tons from furnaces which ten years ago had averaged less than 85-ton capacity. Insulation of the furnace bottom, directly over the furnace pan, gives a quicker melting furnace, with less temperature difference between the top and bottom of the bath. Bottom insulation is particularly required if the bath is deepened without lowering the pan because this reduces the total thickness available for bottom lining. Modern light weight refractories have sufficient mechanical strength to stand the loads imposed by the charge above.

In some shops new furnaces have been built with a rigid permanent binding. In such a design the well-known tie rod disappears. This construction will cause much less maintenance costs in years to come, and will eliminate the tendency of furnaces with sloping back walls to creep toward the pouring pit. When rigid binding is used, the roof brick must be laid with an expansion allowance on the inside face to prevent pinching when the roof is heated up and the crown rises. In older installations, unless the superstructure of the furnace is discarded entirely, this plan is not practical because of the installation costs.

Temperatures of moulds may be taken by means of a contact pyrometer before tar dipping.

As time has gone on, most shops have eliminated the I-beam buckstays and substituted 5 in. x 12 in., or 6 in. x 15 in. rolled slab buckstays in their stead. Such a construction means a more rigid and permanent structure. Most shops now consider sloping back walls to be standard equipment. To my mind, this is one of the greatest labor and maintenance cost saving ideas that has been developed in recent years. It eliminates almost completely the bugbear and excessive cost of burnt out back walls of days gone by.

Furnace ports have come in for considerable discussion. In producer gas practice, water-cooled ports continue to give good results. One shop has had considerable success in using movable ports. Recent experiments have indicated that it will pay dividends in less slag in slag pockets, longer furnace campaigns and lower costs if the inside of the entire port ends, with the exception of the port roof, are lined with basic bricks below the

The important item of stopper rod drying is properly done in this vertical drying oven.

floor level. In some shops the basic brick is carried down to the arch in the slag pocket. The venturi type port has been adopted by quite a number of companies using producer gas as a fuel. Many attempts have been made to improve the division wall design in a two uptake port construction. Several plants have solved this problem by the use of a welded air-cooled box in this arch construction. In certain plants using natural gas as a fuel, the gas is introduced into a gas port at floor level. This procedure allows mixing of some air with the gas before combustion takes place at the nose of the port.

In natural gas, coke oven gas, oil and tar fuel practice, port design varies. Some use a single uptake for these fuels. Such a design is very economical from a rebuilding standpoint. In some plants small water-cooled nose ports with dry burners are used, and others use water-cooled burners in an open two uptake port. Except in gas fired furnaces with side burners, there is a tendency to use a large open port with very little roof knuckle, in order to permit the removal of waste gases at velocities low enough to avoid excessive erosion of the furnace lining. Whatever the design, more and more basic bricks are being used in the rebuilding operations to lengthen the life of this vital part of a furnace. Bulkheads of ports must withstand a tremendous punishment from the dust and vapor laden gases as they leave the furnace hearth at elevated temperatures. Magnesite and chrome bricks as well as olivine rock bulkheads have lasted at least one complete campaign of a furnace. Some operators are considering basic brick for the entire port roof. In many plants front walls are built up to the charging door frame arches out of basic brick. The arches are usually constructed out of silica brick, but basic brick have been tried with good success in some shops. Back walls are laid up with chrome brick, and a facing of plastic chrome ore mix is troweled all over the inside surface.

Water-cooled doors and frames of the box type are almost universally used. Some modifications of this design, such as the panel door, have been developed. In some plants, archless door frames have been tried. Where water conditions are good, they have worked very well. It is occasionally the practice to install a very large door on one furnace in a shop so that large chunks of steel scrap, machinery, molds, etc., may be charged. Recently, a new type of door using the stud tube idea, developed in boiler design years ago, bids fair to change the trend. Such doors lined with a chrome mix have outlasted the conventional type of doors 20 to 1 before requiring relining. Such design eliminates the nasty habit box type doors have of bulging out when the brick lining gets thin or drops out. This stud tube idea is now being tried out also in furnace bulkheads. In this connection, the water supply for water cooling open hearth furnaces is one of the serious problems every open hearth management must face. In those sections of the country where hard water is used, water softening equipment must be installed. In other places acid water must be neutralized. In any case pressure must be sufficient and temperature low enough that the water cooling equipment serves its purpose without too much attention from maintenance crews.

The open hearth furnace roof is the vital part of the furnace construction. Practice varies, but a roof that gives good results is one which has a span of 20 ft. (skewback to skewback) with a 24 in. rise. The bricks along the front and back walls are 18 in. thick with 21 in. ribs every fourth course. In the center of the roof, the thickness of the brick is 15 in. with 18 in. reinforcing ribs. No insulation is used. Practice is divided regarding insulation of roofs. Many operators have come to the conclusion that it is too hazardous with the present quality of roof brick to do much insulating. The desire to find a means to develop better roof brick life has lead many operators to experiment with basic roof patches along the front and rear of the roof. Preliminary evidence indicates that there is considerable merit in this idea. One installation of basic brick in the roof along the back skewback lasted an entire campaign without any patching. Attention should be called to the danger of going too far at the present stage of this development. Basic roof inserts, extending three feet or less from the front and back skewbacks have given good account of themselves in a number of shops under varying conditions, but in a few instances where the operator became too enthusiastic and extended the basic brick six feet from the skewbacks, premature failures resulted due to the different expansion and contraction characteristics of basic brick and their additional weight. As time goes on, undoubtedly, a basic brick will be found which, especially if suspended roofs are used, will be made practical for the entire roof. In most plants, the roof is still the limiting factor in length of furnace campaigns, and any increase in roof life results in considerable saving in total furnace repair cost per ton, even if the higher cost of long life roofs does not show much saving per ton in roof cost alone.

In recent years the trend in uptake and slag pocket design has been to make them as large as the furnace structure will allow. It pays dividends in longer furnace campaigns to have large, well-insulated slag pockets and fan tails to the checker chambers. Invariably the lower parts of the furnace are encased in addition with ¼ in. steel plates. An old idea, in which molten slag is allowed

to run from the main slag pockets into auxiliary pockets on the outside of the regular pockets, has been resurrected in recent years. Where furnace and building design permits, this is a good scheme for reducing the height of slag in the main slag pockets, thus saving money and extending the campaign life of a furnace.

In another shop movable slag buggies are placed under the uptakes. Slag may be removed several times during a campaign with little delay to the furnace operation.

Not much change has been made in checker chamber design because, usually in a reconstruction program, this part of the furnace is not touched except all furnace men agree on very complete insulation of checker chamber roofs, side walls and flues to the stack. This prevents infiltration of air with its attendant decrease in pre-heat and lowering of efficiency in the furnace practice.

The discussion regarding best types of checker brick to use continues. Many shops use a 3 in. x 4½ in. x 10½ in. block which serves their purpose very well and has a high replacement value at the time of rebuilds. Great claims are made by others for special checker brick designs of various types. Some of these have given good results in a number of shops, but have the disadvantage of low replacement value. Others are installed in such a way that checkers can be blown regularly through hollow bricks in the bulkheads. Since 80 per cent of these bricks in some designs consist of regular 4 in. x 9 in. clay brick, the installation cost is not much higher than when using the standard conventional checker brick.

Silica brick are used at times to top off checkers when the checker capacity is insufficient for the furnace capacity. Such brick sometimes has a rather high alumina content. Suffice to say that in shops where oil, tar, or natural gas has been substituted for producer gas as a fuel, there is usually sufficient excess checker capacity so that special designs do not make as good a showing as in producer gas furnaces. The same is true of the claims of exponents of two and three pass checker design. There are a number of shops making just as good records with the conventional type checker chamber and brick design as with these special designs. In recent months another scheme, which is designed to drop out maximum amounts of flue dust has been tried out. It incorporates a two pass principle whereby the gases go up through the checker columns from the slag pocket level, instead of from the top of the checkers down through to the stack flues. This idea may have considerable merit from the standpoint of longer furnace campaigns. In most plants, some plan for partially cleaning checkers, during a campaign, is being tried out. Some dig wells in the rear of the checker chambers and then blow the checkers with compressed air or steam. Others have a number of sleeve brick installed in large doors in the rear of the checker chambers. Long pipes may be inserted through these holes to blow down the accumulated dust with air or steam without shutting down the furnace. Still others have steam lines laid in the bottom of the chambers which are so arranged that the steam can be turned on to blow out the dust at frequent intervals.

Fortunate is the plant that has sufficient space below the checkers between the rider walls to obtain the most benefit from this practice.

As the life of the furnace proper, ports, uptakes, and

This view illustrates the use of a safety car between the slag thimble car and the oil-electric locomotive.

slag pockets is increased through the use of more refractory brick, more and more attention will be paid to the design of the checker chambers, type of checker brick, and some methods for continuous, economical removal of oxide deposits from under the checkers. There is a crying need for better method to remove these deposits. Vacuum apparatus has been tried. Recently, a report has been received that a screw conveyor is being tried out. In most plants, it is still a dangerous, dusty, hot, back-breaking labor job.

Damper reversing valves in straight line flues are now standard equipment for most shops. Much progress has been made in eliminating warpage and leaking of water-cooled seats and dampers. In a few shops valves have been eliminated entirely, and the Isley system substituted. In this design there is a sub-checker chamber beyond each set of old checker chambers, and flues lead to a short venturi stack on each end of the furnace. Such stacks are served by fans operated by 100 hp. motors. With normal electric current prices, the cost to operate such fans is about $0.08 per ton. Isley furnaces have no valve leakage, cooling, or maintenance costs. They have ample draft at all stages of a furnace campaign, and have shown outstanding fuel economy and high production rates. Since the air and waste gases are moved by fan pressure instead of by natural draft, the irregularities in flow of gases and furnace pressure, due to variations in checker temperature, necessary for the regeneration cycle, are smoothed out, resulting in much more regular and consistent furnace performance. Furnaces rebuilt from 75-ton into 160-ton furnaces with a 35 per cent hot metal charge and making low carbon steel have been able to produce 10,000 gross tons of ingots in one month.

In some plants waste heat boilers have been installed to recover some of the waste heat going to the stack. The horizontal flre tube boiler seems to give the least trouble and the best results to date. A steam credit of fifteen to twenty cents per ton of steel is frequently obtained from these waste heat boilers.

INSTRUMENTATION

Gadgets to improve the furnace operations have gone through the usual cycle; high pressure exploitation, disillusionment, and then a gradual recognition of the merits of some of these aids for the furnace helper.

The thermal system of an open hearth is an involved affair which may be influenced by many factors. A change in design to gain control of one factor may throw others out of control with the result that the manipulation which was expected to be beneficial has, instead, an adverse effect on performance. This margin of leeway between the furnace temperatures necessary for open hearth operation and the flame temperatures that can be developed with conventional fuels is so exceedingly close that a deviation which may seem insignificant at first thought may be found to have a critical influence on the performance of the furnace.

Automatic reversal of valves and fuel is not a panacea for the ills of a furnace. Manual reversal of valves based on a temperature differential in the checker chambers gives good results where furnace men have been trained to have the interest of the company at heart. When such a system is used conscientiously, there is a question whether expenditures to make reversals automatic are justified. A signal system—both light and bell—in the manual scheme notifies the furnace man when valves should be reversed. This scheme saves time, makes possible more uniform reversals, and more efficient preheat, which tends to lower fuel cost and improve furnace repair costs.

Air-fuel ratio control is a sensible approach to the problem of how to burn the fuel so as to gain both high production and low fuel consumption. The marginal working limits are vitally important in this connection, and any departure from the proper fuel and air conditions is bound to slow up the furnace. However, the controls usually supplied for this purpose fall short of their intent if they fail to compensate for two variables, either of which may have considerable effect at critical periods of the heat. One of these is the variable oxygen content per unit volume of air due to atmospheric temperature and humidity change. Changes of oxygen delivery to the furnace amounting to 10 per cent due to temperature changes are not uncommon within a twenty-four hour period, particularly in the fall and spring months. The change in oxygen delivery due to moisture content of the air is much smaller and usually does not change so quickly except in the rainy seasons. The second variable involved is that due to the gases evolved from the bath. This variable assumes more importance when it is realized that the greatest disturbance from this cause always comes at a critical period when it is doubly important that highest possible heat transfer be maintained.

Air conditioning would solve the problem of variations in air supply but the cost and complications of such a project stagger the imagination. An air-fuel control based on the oxygen content of the outgoing gases, after all, would supply a comprehensive solution for this problem, but up to this time, the difficulty of keeping sampling tubes open has prevented the adoption of this method of control. To date, no practical apparatus for continuously determining oxygen content of flue gases under the conditions existing at the outgoing end of an open hearth furnace is available.

Automatic draft control probably has been more widely applied than any of the controls ordinarily used on open hearth furnaces and properly so since perfect control of incoming fuel and air would have little value if the pressure within the furnace was not held at the proper point. Reasonably accurate draft control can be obtained by manual adjustment based upon the appearance of the flame at the peep-holes of the open hearth doors. This is a sensitive indicator of furnace draft. Roof temperature control thermocouples have been developed to the point where they give satisfactory temperature indications for the points at which they are located, but the first helper must still watch his roof to be sure no hot spots develop at points not protected by thermocouples.

It is, of course, essential to know the pressure and temperature of the water in the open hearth furnace cooling system. Temperatures of the oil or tar, as well as the pressures, must be known and recorded. In the case of producer gas, steam pressure and temperature of the gas, as well as its analysis, are very important to

the first helper. In addition, he should know how much fuel he is burning per hour. An ingenious recording instrument, known as a totalizing meter, makes it possible to know how much mixed fuel-gas and oil or tar is being used per hour. Careful attention to maintenance of fuel oil, or tar systems, as well as atomizing steam at high temperatures and regulation of the amounts of each used at various stages of the heat will pay dividends in lower fuel costs and faster heats. The adoption of the oil mill to minimize the problem of sludge in heavy oils has made it possible to use high Btu. oils under 10 degrees Baume as a fuel in the open hearth furnace.

So many things can happen to an open hearth fuel system to affect its operation that the assignment of a high-type man to full-time work as combustion man in the open hearth pays good dividends. To get the best results, such a man will keep careful records of fuel performance, by furnace and by heat, will make detailed checks of furnace conditions, and, most important of all, will spend enough time with the furnace men to get their confidence and cooperation and to make sure that they have a clear understanding of what their furnace is doing.

Preliminary carbon determinations may be made rapidly by use of one of the modern instruments developed for the purpose.

PIT PRACTICE

The open hearth pit is often the scene of a great many difficulties. First, the tap hole of a furnace needs constant attention to prevent breakouts, delays, and bad quality. When the hole shows signs of getting short or too large, it should be piped with a 6 or 8 in. steel pipe, depending on the size of the heat and the grade to be made. The pipe is usually 4½ ft. long. Short tap holes may allow the slag to siphon down into the runner long before all the metal is out of the furnace. This is detrimental to quality steel production. Large taps make it difficult to show good economy in the addition of ferro-manganese and other alloys.

Back standings should be reinforced and well built. They should be wide enough to give ample space for safely working at the tap hole, making ladle additions and, if possible, provide enough space to mud up the runners. Above all, safety cables should be available to place across the back standing to protect men from falling into the ladle or ladle pit.

Not much progress has been made in improvement of runner design. Usually they are lined with brick and a slurry of mud smeared over the brick. One operator has attempted to improve runner conditions by using a mixture of ground graphite and fire clay on top of the clay brick lining. Because of the danger of inclusions, due to linings of runners being washed out by each heat, progress must be made in improving these linings. From a safety, yeld, and quality standpoint, it is essential that runners must be thoroughly dried before the heat is tapped.

Pit runways must be strong enough to handle the live loads of hot metal and the slag in this area. When large heats are being poured, frequent inspection of the crane runways for loose bolts or rivets must be rigidly enforced. When handling increased loads, all working parts of a crane may be strengthened by substitution of alloy steel shafts, gears, ladle trunnions, etc. Laminated ladle bails give a greater feeling of security than the old cast steel bails.

Ladles have undergone many changes; however, the oval welded steel plate ladle gives best results. The oval ladle is relined more easily, skulls may be removed quickly and the ferro-static head is not increased when the size of the heat is increased. The welded ladle allows about 5 to 7 per cent more metal to be poured from such a ladle due to the saving in weight of the ladle. A 1 in. plastic insulation lining between the ladle shell and brick lining saves fuel cost when new lined ladles are dried out, and less heat is lost between charges. It also helps prevent skulls. Ladle linings last longer if heats are charged large enough to allow very little slag to remain on top of the heat when the ladle leaves the tapping stand. In shops making all killed steels, a scheme to spray ladle linings with a thick refractory slurry lengthens the life of the lining. Such a practice is not recommended for live rimming steel. It must be remembered that for quality reasons, between heats, each ladle must be thoroughly cleaned to be sure no loose clay or brick is allowed to remain. It is preferable to use all-brick bottoms in the ladle instead of rammed loam or clay coverings on top of the bottom brick.

In a number of plants double pour stopper rods are used in ladles to expedite the pouring of large heats of steel, as well as minimize slag-metal reactions in the ladle.

Vertical stopper rod ovens, thermostatically controlled, insure the most efficient handling of stopper rods, especially if a definite routine is developed and every detail of stopper rod assembly closely controlled day by day. In a properly regulated shop, a running stopper is a rarity. For obvious quality reasons, care must be exercised in eliminating all excess clay around joints of sleeve brick.

Again it will pay dividends to any shop to set up rigid inspection standards for stopper heads, nozzles, and sleeves for stopper rods. Brick must not be burned too hard or they will crack. Neither should they be too soft or they will wear away very rapidly if high iron

The use of insulating concrete on regenerator chamber walls, roofs and flues is now common practice.

oxide heats are tapped into the ladles. It pays to carry two or more month's run of these brick, stored in a warm place, to season them before use. In some plants, nozzles are tested for trueness of seating contour. Out of round nozzles are ground to an exact fit avoid leaking or running stoppers.

Experiments continue to be made to develop nozzles which will not burn out so rapidly. A nozzle which has fire clay in the upper half and magnesite in the lower half shows some promise. When teeming slab moulds, nozzles having tapered oval orifices are used in several plants to help prevent stream splash.

The pit is equipped with auxiliary aids, such as magnets for scrap, large strongly constructed dump buckets for rubbish, dump cars, flat-bottom cars for large chunks of steel and breakouts, hoppers for additions to ladles, a storage track through the pit, and tracks at pouring platforms. Steel ties will save maintenance cost. There should be enough pouring platforms to minimize tapping and teeming delays. These platforms must have enough width to give ample safe working space for ladle crews. There should be safety platforms for the ladle cranemen, and for the crews, running the entire length of the pit at two levels on the outside of the pit building. Capping cranes help expedite the work of ladlemen in placing heavy caps on large moulds when rimming steel is teemed.

Modern open hearth shops have oxygen piped to the floor, back standing and pouring platform. This is a godsend to furnace and pit men and eliminates many hours of laborious work, saves metal loss, and maintains a higher average quality of steel produced in the open hearth department.

In case hot top moulds are used, a separate building is usually provided where the drags may be cleaned, and hot tops made up and put on the moulds. In shops producing alloy steels, big end up hot topped moulds are essential. About 15 to 17 per cent of the total volume of the ingots goes into the hot top. This top may be a brick hot top, or a metal holder with a mastic insert. In other shops producing killed steels, hot top bricks are, at times, placed on top of the regular big end down moulds. In such cases often as low as 12 per cent of the total volume goes into the hot top. The larger the mould the more economical will be the gain by the use of a composition hot top in a steel or iron container, rather than an all brick hot top.

In modern shops, bottom pouring of ingots is done on specially designed buggies. From 50,000 to 70,000 lb. of metal are poured on a single buggy. To avoid inclusions, all bricks in center runners and bottom plates are laid without fire clay between the joints.

More and more welded ingot buggies are being placed in service. Again roller bearings and automatic couplers, and oil-electric engines lower delays and maintenance costs.

Slag is poured into one or two slag pots as the heat is being tapped into the ladle. These pots may be cast iron or they may be steel. In the latter case, they are heavily corrugated to avoid warping. The claim is made that such pots are almost indestructible. The slag in these pots is either hauled to the dump in slag cars and wasted, or it is crushed, and in some instances, granulated and returned to the blast furnace where it becomes part of the charge of that unit.

Mould cleaning is a very important operation in the pit area. Each drag, as soon as it is stripped and cooled, is thoroughly cleaned, defective or worn out moulds are removed, and then the moulds are either given a graphite spray coating, or sprayed or dipped in tar or pitch. Every phase of this operation must be controlled very carefully for good results. A plan for teeming drags of moulds in regular rotation will keep them in best condition for teeming, increase the mould life, and improve the quality of the steel.

A special dished contour stool with mould to match is being tried out in several plants. The claim is made that several per cent of good steel may be saved in the rolling mill by the use of such design. The copper insert and all-copper stools were tried out by many plants a few years ago. In a number of plants this experiment has been abandoned, usually because of warpage and fire cracking difficulties.

To keep the moulds in best condition, and to avoid quality losses later on, as a result of teeming into rusty or cold moulds, in a few plants, brick mould drying ovens have been built. In these ovens, there are usually three tracks, each one of which holds one drag of moulds. Moulds are dried by placing hot drags alongside of the cold ones.

One eastern plant has found it practical to lengthen the life of its molds by reconditioning the fire-cracked interior surface by the use of grinders.

METALLURGICAL CONTROL

If the mechanical improvements have been marked in the open hearth department, the interest in metallurgical practice has been just as keen. The shop that

believes in the haphazard control of rule of thumb operations is a back number.

Now management centers quality control in a plant metallurgical department whose responsibility it is to supervise and check quality from the blast furnace through all operations to the performance of the steel in the customer's plant. In carrying out these functions, they are independent of operating supervision and report directly to the works management.

To make such control meaningful to operators, observers are stationed in each department, who check every phase of operations and make record of every departure from standard practices, which have been set up for such operations, as well as the reason for the same, and suggest solutions for quality difficulties. Such records can show trends toward better or worse quality, and thus the metallurgical department can help avoid a serious plant slump in quality before it has gone too far.

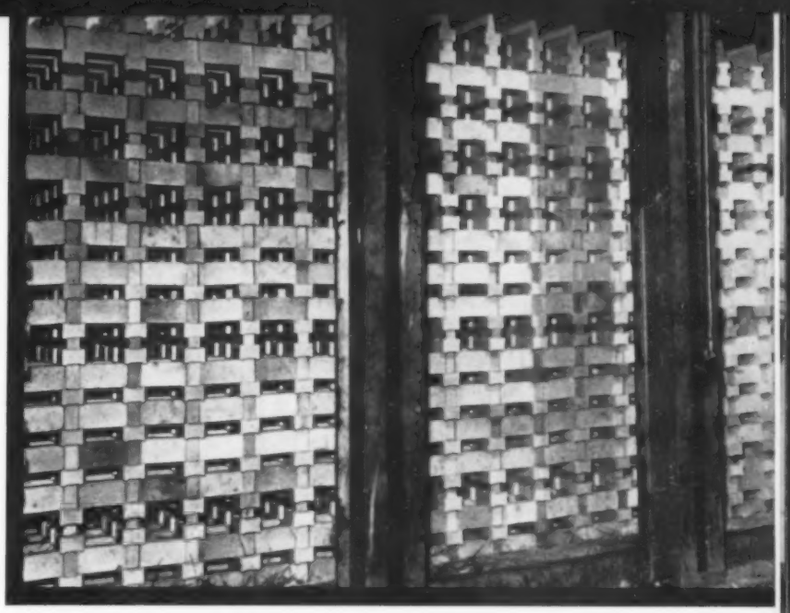
In this connection, open hearth raw materials are checked for physical condition and chemical analysis. Furnace charges are standardized, operating conditions in the furnace and the pit are checked, and refining and pouring practices are regulated. The metallurgical engineer has given the operator, by means of chemical analyses, tests for slag and metal to check the progress of refining. Bomb tests may be used to check degree of oxidation of the metal in the furnace. Viscosity and slag cake tests show consistency of the slag. Now new methods for taking the temperature of the metal bath are adding the final control needed for quality production. A survey of the practice in a number of the leading steel companies indicates that metallurgical observers, in most cases, are given authority to degrade questionable heats or ones that do not meet standard specifications set up in the metallurgical department.

All in all these metallurgists stress uniformity and cleanliness (especially from an alloy contamination standpoint) of the charge; sharp working furnaces; uniformity and regularity of ore and other furnace additions; proper tapping temperatures, and operating conditions; careful and proper ladle additions, as well as careful efficient addition of deoxidizers to the ladle and moulds, and clean pit and mould preparation practices.

MISCELLANEOUS FACTORS

In the operation of any modern shop, records of performances are absolutely essential. Certain ones may be cited as being more important than others; First, a standard force report for comparison with the record of actual men used during each 24 hours; second, car unloading report; third, detailed charge sheet by furnaces and heats; fourth, delay reports, showing operating, electrical and mechanical delays in each major section of the department with reasons for the delays; fifth, a report showing furnace melting and metallurgical practice by heats, as well as pit and mould practice.

Of course, the open hearth superintendent and his engineers make intensive studies every day of each phase of open hearth operations by means of these records to spot bottle-necks in the operation, or weak links in the chain of production so that they may be minimized or eliminated entirely.



View from the rear of regenerator chambers showing checker work of special design in a 125 ton furnace.

While the mechanical and fuel engineers have been assisting the open hearth superintendent improve the mechanical part of these operations, the industrial engineer in progressive plants has been equally busy. He has sold management on the idea that the foreman is the key man in industry today. He has been permitted to help the mill foreman study the psychology of directing men for best results. He has helped set up practical job-training and technical courses for the furnace, stockyard and pit men. Maintenance crews have been taught how to prevent delays and breakdowns rather than follow the old formula of fixing a break after it has occurred.

TABLE I

Safety

Year	Frequency	Severity
1933	13.17	4.42
1934	14.03	3.74
1935	11.16	4.85
1936	12.82	3.12
1937	11.68	3.99
1938	9.19	4.80*
1939	7.09	5.26

*All figures except this one from National Safety Council tabulation of all open hearths. Their 1938 figure not available. This figure composed of results of 17 reporting open hearth shops in seven-company exchange.

1939 figures represent safety experience of 36 open hearth shops.

From a safety standpoint, work in the open hearth department was, for years, considered to be in the extra-hazardous class. Safety engineers have helped change this situation. Standard safe practice instructions have been written for every job in the open hearth department. Men have been trained to follow these instructions and have been given first-aid training to minimize the effect of accidents when they occur. In addition, management has spent money wherever necessary adequately to guard all machinery. Safety switches for electric cranes as well as bell and light transportation signals have been installed. Special safety clothing and equipment, such as fire-proof masks, gloves, aprons, and leggings; goggles and safety shoes have been provided free of charge or at cost to the workmen.

Throughout this paper, a number of familiar safety devices have been cited, such as automatic couplers, heat screens, insulation, dolomite guns, tractors, magnets, buckets, etc. The modern tendency has been to relieve the workman of the dangerous, hard, back-breaking, exhausting work of years gone by, and have this work done by machinery. This change has made it possible to recruit young, energetic, intelligent Americans for the open hearth work. They now can think more clearly, and operate more economically. Quality has been improved and costs have been reduced. The motto of the American Rolling Mill Company is: "Every man think first of his safety as he enters the plant, and leave it at the end of the turn without a scratch."

Fair rates have been established which are comparable to work done in other departments and other plants. Bonus schemes have been devised to give the worker extra compensation for extra effort. Managements have worked out plans to compensate top supervision in the department for measurable improvement in quality and cost reduction. Workmen are kept acquainted currently with plant problems by means of foremen and employee representatives meetings with management, as well as weekly service letters to every man in the plant. This latter service has been enthusiastically received. Management tells men about general and plant business conditions, basic economic facts are touched upon, other facts of interest to men presented, and appreciation expressed for outstanding accomplishments.

A few of the drastic changes that have taken place in the open hearth business during the last ten years have been evaluated. Throughout all these changes, emphasis has been placed on the human element, and an effort has been made to improve the workman's wages, his working conditions and general plant environment. It is a proven fact that American workers have reacted to such fair treatment by cooperative effort in the production of more and more tons of ingots in these new or revamped plants, quality has kept pace with the growing needs of our mechanized era, and costs have been reduced to help management meet the keen competition faced at the present time by every plant producing steel ingots in this country.

DISCUSSION

PRESENTED BY

J. A. CLAUSS, *Chief Engineer,* Great Lakes Steel Corporation, Ecorse, Michigan.

A. E. ABEL, *Chief Engineer,* Valley Mould and Iron Corporation, Hubbard, Ohio.

A. F. MORANTY, Leeds and Northrup Company, Cleveland, Ohio.

M. J. CONWAY, *Special Engineer,* Lukens Steel Company, Coatesville, Pennsylvania.

L. F. REINARTZ, *Manager,* Middletown Division, American Rolling Mill Company, Middletown, Ohio.

J. A. CLAUSS: I have read and listened to the reading of Mr. Reinartz's paper with considerable interest and wish to compliment him on the thorough manner in which he has covered every phase of open hearth furnace equipment and operation. There is little that can be added except to emphasize the importance of auxiliary equipment for an open hearth furnace plant.

In the construction of an open hearth furnace plant or a rolling mill, the furnace or mill seems to be the chief source of interest and too little attention is given such vital auxiliaries as the track system for the transportation of the raw and finished material, the sewers, power and pipe-line systems, cranes, ladles, storage bins, etc. I am glad to note that Mr. Reinartz, as an operator, recognizes the importance of these necessary auxiliaries, the successful operation of which are an absolute necessity to any furnace or mill. They are, in my opinion, equally as important as the furnace or mill proper, and therefore should receive careful thought in their design and arrangement.

The amount and arrangement of the tracks, the size and location of the sewers, power and pipe-line systems and other auxiliaries should be such in a new plant layout to take care of the ultimate future expansion; otherwise, costly shut-downs will occur when extensions are made.

After many years of study and collection of data, it was my good fortune to be the engineer in charge of the building of an open hearth furnace plant on a clear site. I found a wide difference of opinion among engineers and operators as to the proper arrangement and auxiliaries required for an open hearth furnace plant.

At Great Lakes, eleven years ago, we incorporated practically all of the suggestions outlined in Mr. Reinartz's paper and have found them to be well worth-while.

At Great Lakes the stock house is north of and parallel to the open hearth furnace building. It is 105 ft. wide x 1200 ft. long and equipped with five 15-ton overhead cranes, having a bridge speed of 450 ft. per min., a trolley speed of 250 ft. per min., and a hoisting speed of 53 ft. per min. Each crane is equipped with a 65 in. magnet.

We generally load charging boxes from standard railroad cars. One charging car track 1200 ft. long is located along the south side of the building and has a capacity of four trains of twenty-three charging cars each. One track 1200 ft. long is located north of and parallel to the charging car track and has a capacity of twenty-four standard railroad cars. There is a short track 200 ft. long extending into each end of the building along the north row of columns. Near each end of the stock house is located a 300-ton standard gauge railroad track scale with a 40 ft. 3 in. effective weighing rail. These scales are so located in relationship to the stock house and the open hearth furnace building that the material can be weighed as it leaves the stock house on its way to the approach trestle to the charging floor; there being an approach trestle at each end of the furnace building.

The charging boxes are steel castings and are 30 in. wide x 7 ft. 6¼ in. long x 18¾ in. deep and have a capacity of 27 cu. ft. The charging buggies hold four charging boxes, have steel casting bodies, roller-bearing equipped with link and pin couples.

Our No. 1 open hearth furnace plant contains twelve furnaces and the No. 2 furnace plant contains four, there being room for future expansion at the No. 2 plant. For the present we are stocking our sixteen furnaces from No. 1 furnace plant stock house.

We are tapping better than 200 tons per furnace. Diesel electric locomotives, 70 and 100 tons, are used to stock the furnaces.

The charging floor tracks of our open hearth furnaces were carefully planned and are arranged in our No. 1 shop with five cross-overs for the efficient charging of the furnaces. At each end of the furnace building there is a hot metal scale and ladle pit for the transferring of the hot metal from the 110-ton hot metal mixer type transfer cars to the 75-ton ladles which are carried by overhead cranes to the furnace to be charged. The location of a scale and ladle transfer pit at each end of the furnace plant cuts down the distance that the hot metal must be carried. A hot metal transfer car and track on the charging floor is also provided and can be used when desired.

Our blast furnaces are located about two and a half miles from the open hearth furnaces, and we use ten hot metal mixer cars for three blast furnaces producing about 2200 tons of iron a day.

Our furnaces are 16 ft. x 48 ft. at the fore plate line with sloping back walls and are equipped to burn oil and mixed blast furnace and coke oven gas fired through a single combination burner at each port end. The furnace bindings are laminated and made of five 1 in. x 15 in. plates tied across the top with two 15 in. channels. These laminated buckstays are as straight today as when they were first erected some eleven years ago.

Each open hearth furnace has a fire-tube waste heat boiler having 6000 sq. ft. of heating surface generating 1600 lb. of steam per hour at 150 lb. pressure and 100 degrees F. super-heat.

I could go on at considerable length and tell you in detail about the auxiliaries we installed at our open hearth plant so that you could see how close we have approximated the auxiliary equipment suggested by Mr. Reinartz in his paper, as being necessary for a successful open hearth installation. This is not the time to do so, however. Most of the open hearth operators present have visited our plant, and are more or less familiar with these details.

Mr. Reinartz's interest in open hearth design and operation is well known, and he has again made a worth-while contribution by submitting in detail his ideas in the paper just read. If more of our operating officials would clearly outline what they consider necessary for a successful installation, the engineers responsible for the construction would be better able to develop a design and provide the equipment desired. I have frequently stated that if you can hook up a good operating man with a good engineer, you have a team that will be hard to beat.

The chief reason for the existence of the Association and meetings such as this, is to bring all those interested in the design and operation of steel plant equipment together so that there can be an exchange of ideas which should result in much good for the industry in which we are engaged,

A. E. ABEL: Mr. Reinartz's excellent paper has covered the field so thoroughly that it is difficult to supplement the information given. Many of the subjects mentioned in his paper can of course be discussed in detail, time permitting.

One item of major importance to open hearth operation is proper selection and treatment of ingot moulds, stools and hot tops for the particular grade of steel being manufactured.

Twenty years ago, the majority of steel ingots were top or bottom poured in square or slab big-end-down moulds, with little or no attention paid to mould design, mould treatment, or preparation of moulds to receive the steel. In this same period we find great strides have been made in the production of quality steel requiring a larger proportion of hot topped big-end-up moulds with increased attention being given to contour of the mould chamber, thermal design of the mould, quality of mould material, stools, bottom plates, refractory hot tops, bottom plugs and runner brick. The advent of the wide strip mill has added new requirements of large slab moulds for both top and bottom pouring big-end-down, either open top or closed top.

Each plant has its own peculiar characteristics of operation and requirements of mould equipment. Increased supervision and control of this equipment, while an additional burden to the steel producer, has been fully warranted by increased life of mould equipment, improved results in ingot surface and internal structure. With the present day tendency of recording and following each heat of steel from the ladle into the

various designs and types of moulds, much improvement has been made. Mould manufacturers are always attentive to the problems of the steel operator and by continued close cooperation and discussion of experience in the various plants, there is no doubt that additional improvements can be expected.

A. F. Moranty: It has been a long, long period of slow appreciation of the problems involved and of hard work on the part of instrument companies to get the open hearth man instrument-minded, and the work ahead is to get real intelligent use of the tools which I think management is now beginning to see can be used to the advantage of all. I think the results which will be shown in the next year or two will depend entirely upon the use of the equipment which will be installed in an increasing number of shops.

M. J. Conway: Mr. Reinartz mentions in his paper that welded steel charging buggies may in time be designed. By way of information, such a buggy has been in use for several years in an eastern steel plant.

With the author's permission I would like to develop more information on some of the points mentioned in his paper.

1. Mr. Reinartz mentions that splash during pouring is eliminated by using tapered, oval nozzles. I would like to know on what size of moulds this type of nozzle has been used successfully, and of course, whether top or bottom poured.

2. On the question of hot tops for silicon killed steels, Mr. Reinartz gives some definite information on the percentage of metal used in the hot tops. On big-end-up moulds, it is 15 to 17 per cent, and on big-end-down moulds, approximately 12 per cent. These figures seem lower than general practice and more information will be appreciated.

3. Mr. Reinartz states that ingot moulds are coated with tar, pitch, and graphite, and explains that it is necessary to have good control of all operations to obtain good results. Cleanliness and temperature of ingot moulds are two very important factors, and I would like to have the author's suggestions on the best method of temperature control and recommended temperatures.

4. It is interesting to learn that some companies are now experimenting with a few courses of basic brick in the roofs of open hearth furnaces. Density is a very important factor in this case and we are wondering if Mr. Reinartz will enumerate other factors which will preclude the use of a basic brick in the roofs of open hearth furnaces in general practice.

5. Can Mr. Reinartz tell us what progress has been made during the past year in the development of apparatus or thermocouples for taking open hearth bath temperatures?

6. What mould life increase can be reasonably expected by grinding out the fire cracks in the moulds?

L. F. Reinartz: I am very much in favor of the laminated buckstay that Mr. Clauss mentioned. That is one thing I didn't get into the paper. I believe it is a forward step and a decided improvement. We happen to use slab buckstays 15 in. x 6 in. in the front, but I believe he has a better back wall construction than we have. Our sloping back wall buckstays seem to tend to pull our buckstays toward the rear. We haven't tried the rigid binding, but hope to do so.

Answering Mr. Conway's questions in the order given:

1. In answer to question number one, practically all ingots at the Middletown plant are top poured. Tapered oval nozzles are used on ingots having from 20 in. x 30 in. to 20 in. x 57 in. cross section dimensions.

2. The figures given on top poured silicon killed steels represent practice in several plants on medium carbon steels and ingots weighing from 2½ to 6 tons. On larger ingots a greater percentage of hot topping would have to be used.

3. The best way to record mould temperatures is the contact thermocouple used by several companies. A temperature of 120 to 150 degrees F. gives good results for the graphite coating of moulds. Some plants' managements are satisfied if the temperature of the moulds is less than 200 degrees F.

4. A large number of companies have tried basic patches in basic open hearth furnace roofs with varying results. It appears that it is not safe to shut down a furnace having a basic patch in the roof very often for repairs, or the roof may buckle. Also, the patch should not be more than 2 ft. wide or it will cause buckling. Basic patches are not a foregone success, as yet.

5. During the last year, the United States Steel Corporation appears to have made most progress through their research laboratory studies in taking open hearth bath temperatures. A water cooled tube, containing the thermocouples, is passed through the wicket of the water cooled door and pushed through the slag into the metal. The reading is made on an instrument on the floor. This method is still in the experimental stage.

6. We are told that the mould life can be increased from 15 to 20 per cent by grinding out fire cracks, if this operation is carried on when the mould first shows signs of such cracking.

NEW MEMBERS

Active

James Trimble
Foreman, Electrical Repair Shops
American Rolling Mill Company
Ashland, Kentucky

F. R. Benson
Supervisor
Electrical Department
Carnegie-Illinois Steel Corporation
Lorain Division, Johnstown, Pennsylvania

A. J. Berdis
Chief Engineer
Irvin Works
Carnegie-Illinois Steel Corporation
Dravosburg, Pennsylvania

F. G. Kredel
Superintendent
Finishing Mills
Republic Steel Corporation
Cleveland, Ohio

I. E. Owens
Lubrication Engineer
Alan Wood Steel Company
Conshohocken, Pennsylvania

O. J. Holmgren
Assistant Electrical Foreman
Inland Steel Company
East Chicago, Indiana

C. R. Dietz
Chief Operating Engineer
Power Department
Inland Steel Company
East Chicago, Indiana

H. S. Method
Mechanical Foreman
76 in., 46 in., 44 in. Strip Mills
Inland Steel Company,
East Chicago, Indiana

Harry P. Acker
Electrical Foreman
No. 2 Open Hearth
Inland Steel Company
East Chicago, Indiana

B. M. Kingen
Electrical Foreman
Coke Plant
Inland Steel Company
East Chicago, Indiana

F. K. Poliski
Electrical Foreman
Blast Furnaces
Inland Steel Company
East Chicago, Indiana

Lester L. Quinlan
Electrical Foreman
44 in. Hot Strip Mill
Inland Steel Company
East Chicago, Indiana

V. C. Aldrin
Assistant Electrical Foreman
Cold Strip Mills
Inland Steel Company
East Chicago, Indiana

V. E. Holtslander
Electric Shop Foreman
Inland Steel Company
East Chicago, Indiana

Archibald Bell
Mechanical Engineer
Inland Steel Company
East Chicago, Indiana

Richard C. Diehl
Metallurgical Engineer
Wheeling Steel Corporation
Steubenville, Ohio

Edw. D. Stevens, Jr.
Chief Inspector
Wheeling Steel Corporation
Steubenville, Ohio

Fred C. Anklam
Motor Room Foreman
Wheeling Steel Corporation
Wheeling, West Virginia

A. M. Krieger
Superintendent of Maintenance
Carnegie-Illinois Steel Corporation
Irvin Works, Dravosburg, Pennsylvania

C. Stenbol
Chief Engineer
Algoma Steel Corporation, Ltd.
Sault Ste. Marie, Ontario, Canada

George E. Reiser
Assistant Lubrication Engineer
Bethlehem Steel Company
Lackawanna, New York

Robert A. Miller
Mechanical Engineer
Inland Steel Company
East Chicago, Indiana

F. E. Kelly
Electrical Foreman
Inland Steel Company
East Chicago, Indiana

H. C. Reese
Fuel Engineer
Wheeling Steel Corporation
Steubenville, Ohio

Michael Girman
Foreman
Carnegie-Illinois Steel Corporation
Duquesne, Pennsylvania

Edgar Stentz
Planning Engineer
Maintenance Department
Carnegie-Illinois Steel Corporation
Duquesne, Pennsylvania

J. D. Goodall
Assistant Mechanical Foreman
No. 2 Open Hearth
Inland Steel Company
East Chicago, Indiana

O. W. Wingate
Roller
76 in. Hot Strip Mill
Inland Steel Company
East Chicago, Indiana

H. L. Bodwell
Engineer
Sheet and Tin Plate
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

Richard Rowell
Assistant Superintendent
Electrical Department
Wheeling Steel Corporation
Steubenville, Ohio

James P. Wiley
Assistant Superintendent of Maintenance
National Tube Company
McKeesport, Pennsylvania

W. E. Waldron
Electrical Engineer
National Tube Company
McKeesport, Pennsylvania

J. J. Leahy
Electrical Foreman
No. 1 Open Hearth
Inland Steel Company
East Chicago, Indiana

Wm. H. Mursch
Chief Draftsman
Staff Engineering Bureau
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

H. G. Cover
Engineer
Salvage and Materials
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

D. W. Saunders
Mill Superintendent
Inland Steel Company
East Chicago, Indiana

P. J. Conlon
Mechanical Foreman
46 in. Blooming Mill
Inland Steel Company
East Chicago, Indiana

W. Douglass
Superintendent of No. 5 Mill
Wisconsin Steel Company
Chicago, Illinois

Associate

J. H. Cooper
Welding Engineer
Taylor-Winfield Corporation
Warren, Ohio

C. A. Matirko
Draftsman
H. A. Brassert Company
Chicago, Illinois

J. H. Chevalier
Service Sales Engineer
Westinghouse Electric and Manufacturing Co.
Chicago, Illinois

O. P. Robinson
Sales
Cutler-Hammer, Inc.
Pittsburgh, Pennsylvania

H. D. Irvin
Engineer
American Brake Shoe and Foundry Company
Detroit, Michigan

G. D. Stone
Manager
Process Service
Linde Air Products Company
Chicago, Illinois

J. E. McBride
Vice-President and Chief Engineer
Palmer Bee Company
Detroit, Michigan

W. H. Fitch
President
Fitch Recuperator Company
Plainfield, New Jersey

Ford P. Reed
Supply Sales Manager
General Electric Supply Corporation
Pittsburgh, Pennsylvania

H. Leonard Harper
Staff Engineer
Aluminum Company of America
Pittsburgh, Pennsylvania

Paul L. Reebel
Sales Engineer
Mesta Machine Company
Youngstown, Ohio

J. S. Copley
Sales
National Carbon Company, Inc.
Philadelphia, Pennsylvania

T. L. Mason, Jr.
Winder
American Cast Iron Pipe Company
Birmingham, Alabama

H. C. Olson
Sales Engineer
Bantam Bearings Corporation
Pittsburgh, Pennsylvania

To the Younger Men in the Iron and Steel Industry:

The Constitution of the Association of Iron and Steel Engineers was recently revised. Included in the revisions is a classification of membership designed to fill the demands of the younger men in the iron and steel industry. This classification is known as JUNIOR MEMBER.

Under the revised Constitution JUNIOR MEMBERS shall be citizens of the United States or Canada and shall be persons identified with the Iron and Steel Industry, not less than 18 years of age and not eligible to membership under any other classification. After the age of 27 years, one's classification automatically becomes Active or Associate, subject to the approval of the Board of Directors. The yearly dues are changed accordingly and no entrance fee is required to make the transfer.

Annual dues for JUNIOR MEMBERS are five dollars. There is no entrance fee. JUNIOR MEMBERS are entitled to the monthly issue of the *Iron and Steel Engineer,* the official publication of the A. I. S. E., the privilege of attending all district section meetings (in Chicago, Birmingham, Detroit, Cleveland, Philadelphia, and Pittsburgh), the privilege of attending the Annual Convention and Iron and Steel Exposition, the Spring Engineering Conference, and the regular inspection trips to steel plants.

For full particulars please address inquiries to your nearest District Section office:

Birmingham District Section: A. L. Lemon, 106 N. 22nd St., Birmingham, Alabama.

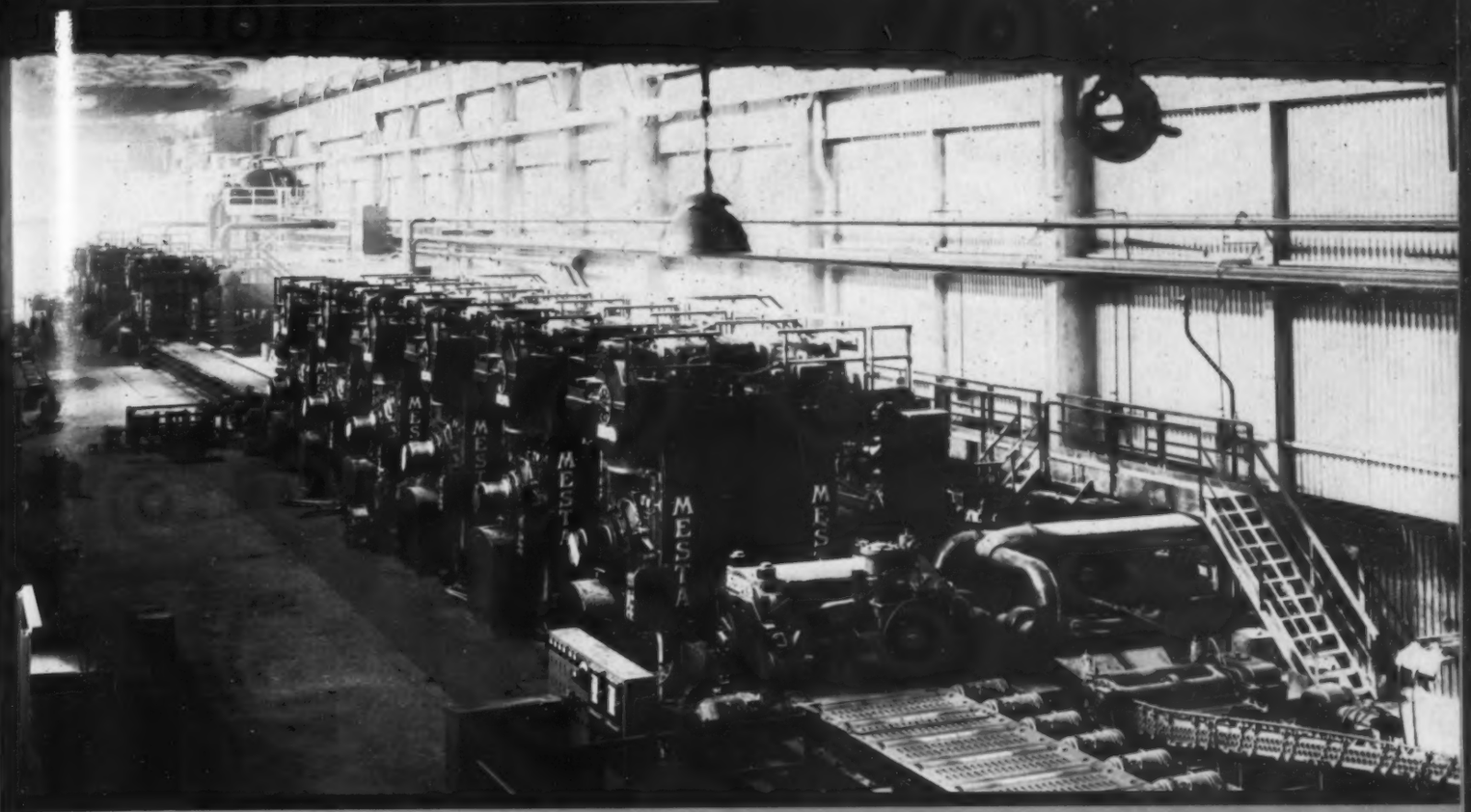
Chicago District Section: A. J. Whitcomb, 310 South Michigan Avenue, Chicago, Illinois.

Cleveland District Section: W. W. Spanagel, 1080 Ivanhoe Road, Cleveland, Ohio.

Detroit District Section: Elmer Weiss, 2755 East Grand Boulevard, Detroit, Michigan.

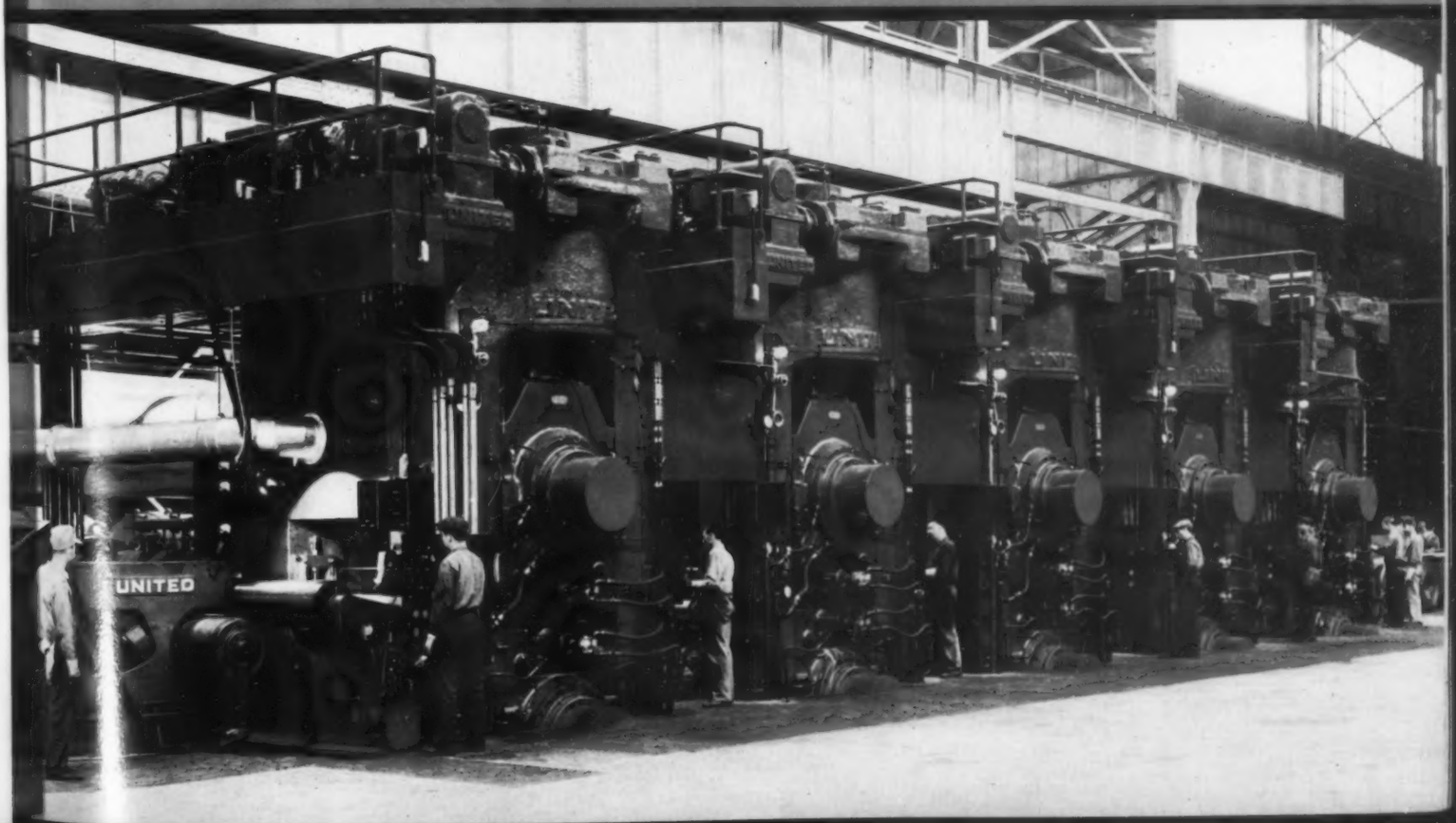
Philadelphia District Section: Linn O. Morrow, Schaff Building, Philadelphia, Pennsylvania.

Pittsburgh District Section: Brent Wiley, 1010 Empire Building, Pittsburgh, Pennsylvania.



YOUNGSTOWN SHEET & TUBE COMPANY

Chicago District



1940.

Youngstown Sheet and Tube Co.

CHICAGO DISTRICT

By T. J. ESS *and* J. D. KELLY *with personnel photographs by* J. R. SCOTT

▲ THE Youngstown Sheet and Tube Company, ranking sixth among steel producers of the United States, was organized in 1900, and, through a well-planned program of mergers and construction, has attained a production capacity of 3,590,000 tons per year, with a well diversified line of products. An important step in the development of this company to its present standing was its entry into the Chicago area in 1923, through the purchase of the plants of the Steel and Tube Company of America. These plants, now known as the Chicago District of the parent company, have been expanded and modernized, and today present a completely integrated layout.

The main plant in this district is located on a site of about 380 acres at Indiana Harbor, about 20 miles from Chicago, on the shore of Lake Michigan. It includes two batteries of by-product coke ovens, two blast furnaces, eight open hearth furnaces, two converters, blooming mill, billet and bar mills, skelp mill, merchant mills, pipe production facilities, and a modern wide strip mill. Excellent transportation facilities are available for both railroad and water shipping. The Youngstown Sheet and Tube Company is part owner of three companies operating 52 vessels on the Great Lakes, and of thirteen companies operating ore mines on the Mesaba, Cuyuna and Vermillion ranges in Minnesota, and on the Gogebic, Marquette and Menominee ranges in Michigan, making over 3,500,000 tons of ore available annually. A coal capacity of 2,270,000 tons per year is provided by the Nemacolin mine in Green County, Pennsylvania, and the Dehue mine, in Logan County, West Virginia, both company owned. Limestone comes from a partly owned quarry at Hillsville, in Lawrence County, Pennsylvania.

The two blast furnaces at the Harbor plant normally supply all pig iron requirements of the steel plant.

COKE OVENS AND BLAST FURNACES

Coal, ore, and limestone are, for the greater part, received by boat shipment. The unloading dock lies along a canal extending inland from the lake, and is served by two unloaders, each capable of handling 400 tons per hour. Ore and stone are deposited in a trough running the length of the storage yard, which is approximately 1100 ft. x 500 ft., and are subsequently handled to the yard or to the bin system by two 15 ton bridges. Coal is deposited in a large hopper, from which a belt conveyor system moves it to the coal storage yard, over 1700 ft. away. This latter storage, 1050 ft. long x 280 ft. wide, is served by a bridge capable of handling coal at a rate of 1000 tons per hour, and provides enough storage to carry through the winter season. Rail shipments are therefore unnecessary, although a 70 ton car dumper is available.

Coal for the coke plant comes from the Dehue mine, averaging 5 per cent moisture, 33 per cent volatile matter, 7 per cent ash, and .65 per cent sulphur. About 20 per cent of low volatile coal is used in the mix, which is sized so that approximately 80 per cent passes through a $\frac{1}{8}$ in. screen. Two oven batteries, each of 60 horizontal flue ovens, provide a total capacity for coking 2500 tons of coal per day. Ovens are $18\frac{1}{2}$–$20\frac{1}{2}$ in. wide x 35 ft. long x 12 ft. high, taking a coal charge of $14\frac{1}{2}$ tons per hour. They are underfired with coke oven gas, consuming about 40 per cent of the gas make.

Coke yield totals about 74 per cent, composed of 67 per cent furnace coke, 2 per cent domestic coke, and 5 per cent breeze. Other yields per ton of coal include 11,000 cu. ft. of 535 Btu. gas, 8.5 gal. of tar, 3.0 gal. of light oil, and 5.75 lb. of ammonia in the form of concentrated ammonia liquor. No sulphate is made in this plant. The benzol plant refines light oil from the coke plant at the South Chicago plant, as well as that made in the Harbor plant. A system is installed for phenol recovery from still waste before its disposal.

Coke is discharged on the wharf, conveyed over the ovens to the screening station, and transported by a 36 in. belt conveyor to the bins in the blast furnace high line.

The two blast furnaces at the Harbor plant normally supply all pig iron requirements of the steel plant, producing basic and bessemer grades only, in the proportion of about two to one. The smaller furnace averages 750 net tons per day, and the larger, 1000 net tons per day. Three stoves, 100 ft. x 22 ft., and four stoves, 103 ft. x 24 ft., serve the two furnaces, one of the larger stoves being arranged for use on either furnace. Blast, averaging 47,000 and 60,000 cu. ft. per min., respectively, may be held at 1250 degrees F. by automatic mixer control. The blast is furnished from three turbo-blowers, two of 60,000 cu. ft. per min. and one of 55,000 cu. ft. per min., operating on 185 lb. steam and equipped with jet condensers.

Each furnace is equipped with a dust catcher, a whirler, and a tower washer, and the blast furnace gas is burned in the stoves and the boilers. A thickener and sintering plant reclaims the dust from this plant, and sludge and dry dust from the South Chicago plant are also sintered here.

Blast furnace slag, averaging about 950 lb. per net ton of iron, is hot poured into the lake as a shore line fill. Pig iron is tapped into 60 ton open top ladles, and may then be taken to a double strand pig machine or to the steel plant.

SOUTH CHICAGO PLANT

Additional facilities for coke and pig iron production are provided by the South Chicago plant. Coke is produced in two oven batteries, each composed of 35 ovens, 15–17 in. wide x 40 ft. 8 in. long x 13 ft. high, taking a charge of 16 tons of coal per oven. Coal from the Nemacolin mine is used, and runs about 35 per cent volatile, 6.75 per cent ash, and 1.2 per cent sulphur. This coal is washed at the mine. A total coke yield of 74½ per cent is obtained, in addition to 10,500 cu. ft. of 570 Btu. gas, 10 gal. of tar, 1.3 gal. of light oil, and 22.5 lb. of ammonium sulphate, per ton of coal. Coking capacity totals 1800 tons of coal per day. The ovens are underfired with blast furnace gas, the plant being the first to be so heated in the United States. All coke oven gas is sold to a local utility company.

Coke yields of about 74 per cent are obtained in by-product ovens of conventional design.

J. E. DAILY, *Manager, Chicago District*

Three blast furnaces are also installed at the South Chicago plant, details of which are given in Table I, together with those of the Harbor plant. Here all grades of basic, bessemer, foundry and malleable iron are produced, up to 4 per cent silicon. Production averages about 750 net tons per furnace day on basic iron and about 600 net tons on various merchant grades. Eleven stoves preheat the blast from four turbo-blowers. The gas is cleaned by passing through a dust catcher and a tower washer, and is used in the stoves, boilers and coke ovens. The portion of gas used for underfiring the ovens is also passed through an electrical precipitator. Slag is hot poured to a dump, while molten metal is usually put into pigs. There are three double-strand pig machines, and a variety of pig sizes is produced. If needed at the steel plant, molten metal may be transported there in mixer type ladles, and some molten pig is shipped to a nearby outside foundry.

STEEL PRODUCTION

This property is located on Lake Michigan and the Calumet River. Ore and coal storage, approximately 2700 ft. long x 350 ft. wide, lies along the river, and is served by four unloader bridges.

Steel making facilities provide a total monthly ca-

TABLE I

Blast Furnace Data

	Harbor plant		South Chicago plant		
	1	2	3	4	5
Hearth diameter	18′ – 6″	21′ – 0″	18′ – 6″	16′ – 2″	18′ – 6″
Bosh diameter	22′ – 6″	24′ – 9″	22′ – 6″	19′ – 6″	22′ – 6″
Stockline diameter	17′ – 6″	17′ – 6″	17′ – 0″	14′ – 0″	17′ – 0″
Bell diameter	13′ – 0″	13′ – 6″	13′ – 0″	9′ – 6″	13′ – 0″
Bosh angle	79° – 55′	80° – 32′	79° – 55′	80° – 32′	79° – 55′
Inwall batter	.765″	.953″	.828″	.85″	.8237″
Height, hearth to iron notch	2′ – 0″	1′ – 9″	2′ – 0″	1′ – 3″	2′ – 0″
Height, iron notch to cinder notch	4′ – 7″	4′ – 8″	4′ – 7″	4′ – 3″	4′ – 7″
Height, cinder notch to tuyeres	3′ – 4″	3′ – 5″	3′ – 4″	3′ – 2″	3′ – 4″
Total crucible height	11′ – 9″	11′ – 7″	11′ – 9″	10′ – 6″	11′ – 9″
Bosh height	11′ – 3″	8′ – 3″	11′ – 3″	10′ – 0″	11′ – 3″
Height, straight section	11′ – 0″	14′ – 1″	14′ – 0″	6′ – 0″	12′ – 0″
Height, tapered inwall section	39′ – 11″	45′ – 10″	40′ – 0″	38′ – 10½″	40′ – 0¾″
Height, throat to top	20′ – 0″	17′ – 0″	16′ – 11″	20′ – 5½″	18′ – 5″
Total height, hearth to top	93′ – 11″	96′ – 9″	93′ – 11″	85′ – 10″	93′ – 5¾″
Numbers of tuyeres	10	12	10		10
Rows of cooling plates below mantle	12	12	12	8	12
Rows of cooling plates above mantle	12	13	11	12	12

pacity of about 75,000 tons of basic open hearth steel and 60,000 tons of bessemer steel.

Basic open hearth steel is produced in eight furnaces, two of 140 tons capacity and six of 185 tons capacity. Due to the fact that these furnaces have been redesigned at various times, their dimensions vary somewhat, running 76 ft. 6 in. and 83 ft. overall length, with hearths 46 ft. 2 in. x 15 ft., and 53 ft. x 16 ft. All furnaces are completely insulated up to the knuckles, and are fired approximately half with oil and mixed gas, with an average fuel consumption of about 3,750,000 Btu. per net ton of ingots.

The later furnaces are 83 ft. overall, 53 ft. between the knuckles, and 16 ft. wide with a 16 in. roof with 20 in. ribs, and sloping backwalls. Regenerator chambers are 29 ft. 11 in. long x 12 ft. 11½ in. and 16 ft. 11½ in. wide x 21 ft. 11¾ in. high, with checkerwork about 12 ft. high so designed as to give about 43,000 sq. ft. of exposed surface at each end of the furnace, and 536 sq. ft. of free flue area. Air uptakes give 75 sq. ft. of area, with a port end area of 100 sq. ft. converging down to a throat area of 56 sq. ft. Bath depth is about 2 ft. 4 in. Burners are inclined toward the front wall, their tips being 4½ in. off center in the furnace, and the furnace throat is also 4½ in. off center.

Three of the furnaces are equipped with complete automatic control equipment, including furnace pressure control, fuel-air ratio control, automatic reversal, and a roof temperature indicator. Forced draft fans provide air for combustion to these furnaces. The remaining furnaces have constant fuel flow regulation only.

Four oil storage tanks, totaling 145,000 gal. capacity, supply the circulating oil system, which operates at 165 lb. pressure, 160–190 degrees F. temperature. In addition, a 6 in. pipe line from the coke plant conveys residue or tar to the steel plant.

Hot metal from the blast furnaces is brought to a 670 ton mixer located at one end of the open hearth shop, and subsequently transferred to the furnaces. Furnace charges are composed of 60 per cent hot metal, 30 per cent scrap, and 10 per cent of ore and other metallic additions. From 7 to 9 per cent of limestone is charged, depending on the grade of steel to be made. Heats average about 12 hr., tap to tap, with production rates of 12.5 tons per hour and 16.3 tons per hour, respectively, for the small and large furnaces. A wide variety of grades of steel is produced, running about 10 per cent alloys, 20–25 per cent forging grades, and the remainder rimming steel for slabs and skelp.

Steel is straight poured into ingots of various size, according to its type and ultimate purpose: 23 in. fluted moulds and 24 in. x 26 in. moulds for hot-topped alloy or forging grades; 23 in. x 25 in. open top for semi-killed grades; and slabbing ingots 22 in. x 34 in., 25 in. x 37 in., 25 in. x 42 in., 26 in. x 50 in., and 26 in. x 58 in. The larger ladles have two stopper rigs for simultaneous pouring of two ingots. Moulds are prepared by dipping, three tar tanks and one brine tank being installed in the mould building. The tar dip is used for moulds having a temperature of 250 degrees F. or more, while the brine dip is used for cold moulds or other emergencies.

The hot top building is adjacent to the open hearth building on the tapping side, and contains three platforms which will hold eight sets of hot tops of the permanent type. Three drags of moulds may be accommodated at one time. After ingots have solidified, the

drag is returned to the hot top building, the hot tops are removed, and the drag moved on to the stripper building.

Cranes installed in the open hearth and its auxiliaries are as follows;

Mixer building	One, 100 ton
Scrap yard	Three, 10 ton
Raw material storage	One, 15 ton
Hot metal crane	Two, 150/40 ton
Charging machines	One, 5 ton
	One, 7½ ton
	One, 10 ton
Ladle cranes	Three, 200/40 ton
Stripper cranes	Two, 150 ton
Mould storage building	One, 10 ton
Hot top building	Two, 15 ton
Slag yard	One, 50/15 ton

Four furnaces are equipped with 600 hp. water tube waste heat boilers, and four with 750 hp. horizontal fire tube boilers.

Steel production is further augmented by two 17 ton bessemer convertors, which are served with hot metal by another 670 ton mixer. These units are blown by two 25,000 cu. ft. per min. turbo-blowers. Steel is poured into 23 in. x 25 in. open-top moulds, and 22 in. x 34 in., 24 in. x 24 in., and 25 in. x 37 in. bottle-top moulds. A hydraulic post ladle crane serves for tapping and pouring. About five heats, or 90 net tons, per hour may be produced.

BLOOMING AND BILLET MILLS

Before rolling, ingots are heated in nine blocks of soaking pits, of four holes each. Five blocks contain pits 9 ft. long x 5 ft. 6 in. wide x 8 ft. 9½ in. deep; three blocks have pits 12 ft. long x 6 ft. 10⅞ in. wide x 8 ft. 3 in.; one block, 14 ft. 6 in. long x 6 ft. 6 in. wide x 11 ft. deep. The latter block is a recuperative, one-way fired installation, with automatic control of furnace pressure and fuel-air ratio. One block of the middle group has been recently rebuilt, applying automatic control of reversals, furnace pressure, furnace temperature, and fuel-air ratio.

Eight basic open hearth furnaces produce steel with an average fuel consumption of 3,750,000 btu. per net ton of ingots.

All of the pits are fired with mixed gas, fuel consumption averaging about 1,220,000 Btu. per net ton charged. Gas is introduced through wells rising through the regenerator chambers between the checkerwork and the pit bridge wall. Ingots come to the pits 3½–4 hours after pouring for the hot-topped grades, and about 2 hr. on the common grades. Heating cycles run 1½ to 2 times the track time, somewhat longer than general practice. It is felt that the longer heating cycle made possible by the ample pit capacity has a beneficial effect on steel surface and conditioning costs.

Ingots are handled into and out of the pits by three pit cranes, and a buggy conveys them to the blooming mill approach table.

In the 46 in. blooming mill, rolls 36 in. diameter x 100 in. body length run in water-lubricated composition bearings, driven by an 8000 hp., 5–50–120 rpm., 700 volt d-c. double armature motor. Power is supplied to this motor from a flywheel set consisting of two 3000 kw., 700 volt d-c. generators driven at 360 rpm. by a 5000 hp. 2200 volt induction motor. The mill has a capacity of 90,000 tons per month, averaging 146 tons per mill hour, and producing squares from 6 in. to 11

The 46 in. blooming mill, equipped with water-lubricated composition bearings, has a monthly capacity of 90,000 tons.

in., and slabs ranging 11–53 in. wide and 4–6 in. thick. Under normal conditions, about 40 per cent of the product goes to the strip mill, 17 per cent to billets and skelp, 40 per cent to the merchant mills, and the balance is shipped direct from the bloomer.

Ward-Leonard control is applied to the mill screwdown and the 1000 ton, 54 in. x 6 in. upcut slab shear. A single motor-generator set, driven at 1200 rpm. by a 1000 hp., 2200 volt synchronous motor, is used in the control system, and is composed of two 250 kw. generators for the two 275 hp. motors driving the slab shear, two 150 kw. generators for the two 150 hp. screwdown motors, and a 40 kw. exciter.

In line with the blooming mill, and approximately 300 ft. distant, is the 21 in. billet mill. Between these mills a transfer removes slabs or blooms up to 35 ft. long from the mill line. The billet mill consists of ten stands in line, with three vertical edgers. Details of the mill are as follows:

Stand	Distance from preceding stand ft. – in.	Roll diameter, in.	Roll length, in.	Roll rpm.
1	–	27¼	60	5.91/9.56
2	18 – 0	28¼	60	7.55/12.22
3	16 – 0	27¼	60	9.62/14.43
Edger	–	19	12	15.16/31.84
4	20 – 0	28¼	60	13.05/19.58
5	20 – 0	22⅛	52½	19.95/25.17
Edger	–	19	12	23.88/50.15
6	19 – 0	22	52½	28.34/35.77
Edger	–	19	12	35.56/74.69
7	19 – 0	22	52½	39.99/50.46
8	15 – 0	22	52½	56.53/71.33
9	15 – 0	21¾	52½	77.95/98.36
10	14 – 0	21⅜	52½	106.80/134.77

The first two stands are driven by a 2500 hp., 34–55 rpm., 650 volt d-c. motor, the next two, by a similar motor of 300–450 rpm., and the last six by a 6200 hp., 317–400 rpm., 2200 volt motor. Each edger is driven by a 200 hp., 250–525 rpm., 230 volt d-c. motor. The two d-c. motors receive power from a dual motor-generator set, composed of two 2000 kw., 650 volt d-c. generators and a 5600 hp., 514 rpm., 2200 volt synchronous motor. Each generator is connected individually to one 2500 hp. mill drive motor. The large a-c. drive motor operates under a Kraemer control system, embodying a 900 kw., 249 rpm., 315 volt rotary convertor and a 1150 hp., 315 volt d-c. motor.

The billet mill produces squares running 1½ in. to 6 in., and flats 3–12 in. wide and 1½–2½ in. thick, at the same rate at which steel is supplied to it from the blooming mill.

A steam operated flying shear, with a capacity of 25 sq. in. of hot steel, is placed 21 ft. 6 in. after the last stand of the mill, and about 100 ft. farther along the table is an up-and-down-cut shear capable of 15 cuts per min. Following a skew table are two 30 ft. x 75 ft. cooling beds.

Paralleling the bloom and billet mill line, and connected to it by a transfer, is a 21 in. sheet bar and skelp mill. This mill also consists of ten stands and three edgers, as follows:

Stand	Distance from preceding stand, ft.–in.	Roll diameter, in.	Roll rpm.
1	–	23⅜ – 22½	5.86/11.27
2	9 – 0	22½ – 21¾	8.27/15.91
3	9 – 0	24¼ – 23⅜	12.2/23.48
Edger	–	19½	18.454/55.363
4	16 – 0	21½ – 20⅝	25.39/46.98
5	10 – 0	20⅝ – 19⅞	34.27/65.72
Edger	–	17	69.76/125.36
6	20 – 0	20⅝ – 19⅞	45.89/88.01
7	10 – 0	21½ – 20⅝	57.52/110.3
Edger	–	17	89.78/179.58
8	20 – 0	19½ – 21½	85/165
9	10 – 7	19½ – 21½	85/165
10	10 – 7	19½ – 21½	85/165

The first three stands are driven by a 3600 hp., 156–300 rpm., 2200 volt motor, and the next four stands by a 7500 hp., 134–257 rpm., 2200 volt motor, both operating under a modified Kraemer system.

R. S. POISTER, *General Superintendent, Steel Plant—Coke Plant*

S. T. BALL, *Assistant General Superintendent, Steel Plant—Coke Plant*

View of the roughing stands of the 54 in. hot strip mill, which is rated at 75,000 net tons of strip per month.

Three motor-generator sets, each composed of two 1700 kw., 600 volt generators and a 4400 kva., 2200 volt synchronous motor, are used in this control, and in addition, furnish power to the three 2000 hp., 75–165 rpm., 600 volt d-c. motors driving the last three mill stands. The first edger is driven by a 200 hp., 300–900 rpm., 230 volt d-c. motor, the third edger by a similar motor of 175–350 rpm., and the second edger is driven through gearing from the 7500 hp. main drive motor.

Hydraulically operated loopers are installed in this mill. Six of the mill stands operate in composition roll neck bearings, while the other four stands are equipped with babbitted bearings.

This mill rolls flat material, $7\frac{3}{4}$–$22\frac{5}{8}$ in. wide x $\frac{1}{8}$–$\frac{3}{4}$ in. thick at the delivery rate from the blooming mill. Product from the mill passes through a steam operated flying shear and a rotary shear, and on to three 30 ft. x 60 ft. cooling beds.

Steel surface conditioning is carried on by manual chipping, mechanical chipping, and manual scarfing, in proportions of about 25 per cent, 13 per cent, and 62 per cent, respectively. Two mechanical chipping machines are installed. Billet scarfing is performed at the merchant mills, using bottled oxygen and acetylene. Slab scarfing is done at the strip mill, using bottled acetylene and oxygen from a liquid oxygen plant. It is planned to install a hot scarfing machine, together with central acetylene and oxygen plants, at the steel plant.

The hot strip finishing train is composed of six stands, 22 in. and 45 in. x 54 in., on 18 ft. centers.

J. D. JONES, *Chief Engineer*, and
W. W. FRAZIER, *District Engineer*

MERCHANT MILLS

The two merchant mills are located in parallel buildings on either side of the billet yard in which billet chipping and pickling is carried on. The larger mill is a 14–18 in. unit of 12 stands, in a cross-country layout of five mill lines. The following shows pertinent data of the mill:

Stand	Distance from preceding stand, ft.–in.	Roll diameter, in.	Roll rpm.
1	–	24¼	11.29/33.88
2	37 – 0	24¼	15.58/46.75
3	52 – 0	22⅛	23.2/69.6
4	12 – 0	22⅛	31.62/94.87
5	100 – 0	22¾	35.14/105.43
6a	122 – 0	19	39.13/117.4
7a	119 – 0	19	49.25/147.76
6	–	19¼	51.3/153.92
7	149 – 0	15	77.86/233.6
8	–	15	87.28/261.84
9	–	15	110/330
10	–	15	110/330

The first ten stands are driven through gearing from a 5600 hp., 60–180 rpm., 600 volt d-c. motor, or if desired, the first stand may be driven by a 900 hp., 150–300 rpm., 600 volt, d-c. reversing motor. The last two stands are individually driven by two 1500 hp., 110–300 rpm., 600 volt d-c. motors.

Steel may be rolled in a direct line through the first seven stands and delivered direct from stand 7a at speeds at 245–735 ft. per min. to a hot saw and on to a hot bed 127 ft. 6 in. x 68 ft. 5 in. The hot bed discharge table returns the material through an angle straightener and a shear. Transfers are installed between the first and second mill lines on both sides of No. 5 and 6 stands, and another joins the last two lines, while diagonal tables elsewhere afford a very flexible arrangement. Product leaves No. 10 stand at speeds of 430–1300 ft. per min., and passes to a hot saw, a 270 ft. x 19 ft. 8 in. hot bed, and subsequently to an angle straightener and a shear.

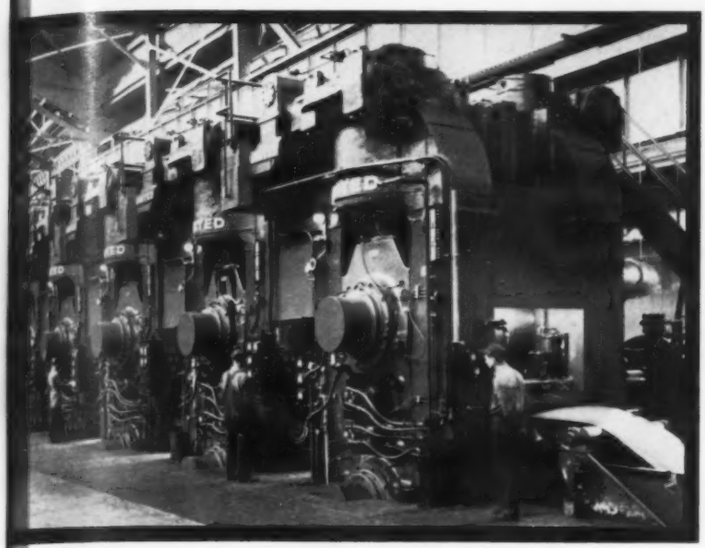
The mill is served by two 17 ft. x 55 ft. continuous recuperative furnaces, side charge, side discharge. They are fired top and bottom with mixed gas, and average about 2,950,000 Btu. per net ton charged. Gas pressure, furnace pressure and fuel-air ratio are automatically controlled.

Production averages about 28 tons per hour, and includes rounds 1 3/16–5½ in., squares 1–6½ in., beams and angles up to 6 in., channels up to 8 in., tieplate, etc.

The tie plate rolled on this mill proceeds to the tie plate shop, which contains two gas-fired heating furnaces and three 900 ton punch presses with automatic feeds. One press is used for cold punching, which is

The hot mill motor room houses all main hot mill drives, with their reduction gear sets, control equipment, etc.

G. T. WILLIAMS, *Superintendent*
Coke Plant and Blast Furnaces



The five-stand tandem mill, 18 in. and 49 in. x 48 in., affords a final delivery speed of 2059 ft. per min.

practiced on the lower carbon steels, while the other two are used for hot punching.

The 10 in. mill consists of five continuous roughing stands, seven intermediate stands (four in line, three looping), and five stands of continuous finishers, all equipped with composition bearings. The five roughing stands are driven by a 1400 hp., 63.3–190 rpm., 600 volt d-c. motor. The next four stands have a 1500 hp., 135–337.5 rpm., 600 volt d-c. drive motor, while the three looping stands are individually driven by 500 hp., 600 volt d-c. motors of 173–432 rpm., 212–495 rpm., and 258–580 rpm., respectively. The continuous finishing train is driven by a 1500 hp., 300–681 rpm., 600 volt d-c. motor. Power is supplied to these motors and to the drive motors of the 14–18 in. mill from three motor generator sets, each consisting of two 1500 kw., 600 volt, d-c. generators, one 1000 kw. 250 volt, d-c. generator, and one 5750 hp., 720 rpm., 11,000 volt synchronous motor. One of the 1500 kw. generators is connected direct to the reversing motor on the first stand of the 14–18 in. mill, while the rest feed into a 600 volt bus which supplies both mills. One of the 1000 kw. generators is used as a bucking unit on the 1400 hp. motor driving the roughers on the 10 in. mill, while the other two supply d-c. auxiliary power. When roughing stand drive motor operates above base speed, the 1000 kw. generator supplies its energy to the common 600 volt generator bus.

Mill speeds, etc., for this unit are as follows:

Stand	Distance from preceding stand, ft.-in.	Roll diameter, in.	Roll rpm.
0	–	13.9	8.31/39.48
1	6 – 2	13.9	11.73/55.73
2	6 – 0	13.54	18.63/88.49
3	6 – 0	14.3	26.47/125.73
4	6 – 0	14.3	39.28/186.6
5	30 – 0	12.04	40.91/102.7
6	4 – 6	12.04	60.23/150.58
7	18 – 0	12.5	82.37/205.92
8	4 – 6	12.5	117.5/293.75
9	–	10.08	173/432
10	–	10.08	212/495
11	–	10.08	258/580
12	–	10.52	300/681
13	3 – 9	10.57	352.49/800.17
14	2 – 9	10.82	404.14/917.42
15	2 – 9	10.87	449.75/1021.
16	2 – 9	11.12	498.78/1132.26

Steel may be delivered at speeds of 825–1875 ft. per min. from No. 12 stand on to a hot bed 430 ft. long x 14 ft. wide, or at speeds of 1445–3280 ft. per min. from

The two continuous pickling lines, 38 in. and 51 in., respectively, give a combined production rate of about 60 tons per hr.

The down-coilers form strip material, No. 9 to No. 20 gauge, into coils 25 in. inside diameter x 48 in. outside diameter, 12,000 lb. maximum weight.

No. 16 stand to four pouring reels. From the reels, a conveyor takes the coils through a cooling muffle. The mill produces squares ¼–⅞ in. and rounds from No. 5 to 1 in. diameter, with an average production rate of about 15 tons per hour. A flying shear is located between the seventh and eighth mill stands.

Heating facilities for this mill consist of one top-fired recuperative furnace, 32 ft. x 32 ft., side charge, side discharge. It is fired with mixed gas, using 1,550,000 Btu. per net ton charged, and is equipped with automatic controls on gas pressure, furnace pressure, and fuel-air ratio.

SKELP AND PIPE MILLS

Skelp production from the 21 in. sheet bar and skelp mill is augmented by a 10 in. skelp mill. Steel for the 10 in. mill is heated in a single continuous furnace, 25 ft. x 32 ft., side charge, side discharge. The fuel rate averages about 1,600,000 Btu. per ton, but varies widely, as either hot or cold steel may be charged into the furnace. The mill, operating in composition roll-neck bearings, is a continuous unit, made up as follows:

Stand No.	Distance from preceding stand, ft.-in.	Roll diameter, in.	Roll rpm.
1	–	11.06 – 10.62	29.42/19.12
3	6 – 3.44	11.50 – 11.06	37.19/24.17
4	4 – 3.68	9.40 – 9.25	65.7/42.7
5 (edger)	3 – 11.99	–	67.4/43.8
6	3 – 8.73	9.68 –9.59	65/100
7	3 – 3.5	9.81 – 9.75	95/146.1
7a	3 – 5.46	9.56 – 9.44	124.4/191.5
8 (edger)	8 – 0	–	82.4/164.8
9	7 – 0	10.12 – 10.03	162.5/232.2
10	8 – 6	9.97 – 9.62	225.4/322.
10a (edger)	4 – 0	–	–
11	7 – 6	10.37 – 9.97	277.13/395.9

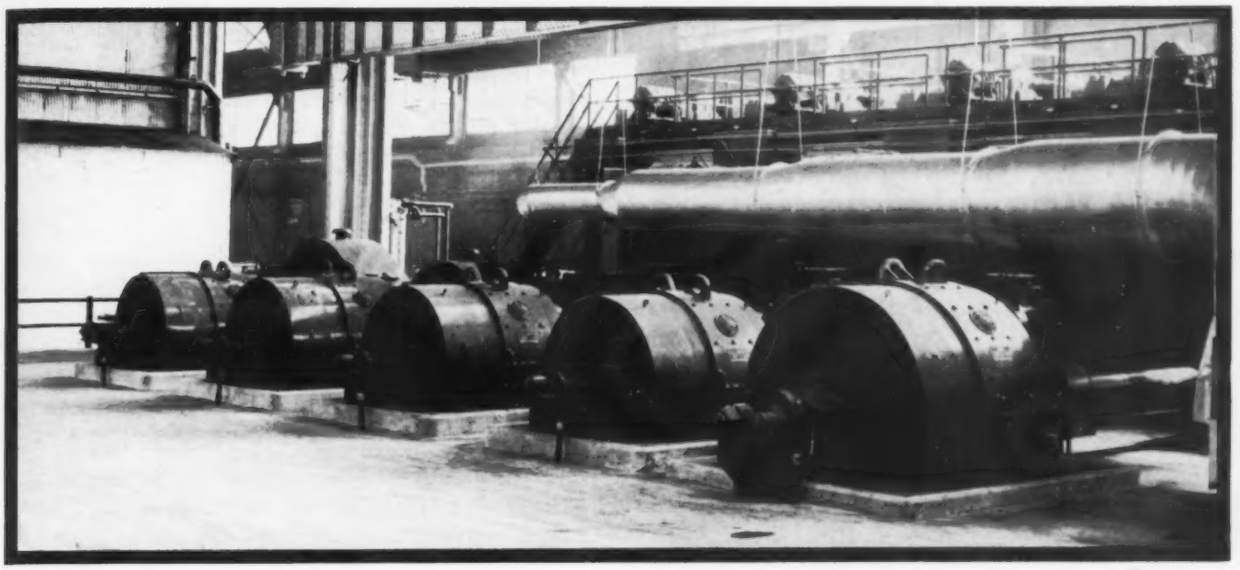
The mill is driven in two group drives. One 2000 hp., 234–360 rpm., 2200 volt motor drives the first six stands through gearing, while another similar motor, of 161–234 rpm., drives the remainder of the mill through belting. Skelp, in widths up to 11½ in. may be delivered at speeds of 725–1070 ft. per min., and may be hot coiled or sent across hot beds to pilers, as desired. The hot coilers, recently installed, are vertical type, with twist guides, a vibrator, vertical shear, and apron conveyor. The reels are each driven by a 32 hp., 575–1725 rpm., 230 volt shunt motor. The mill averages about 28 tons per hour output.

Skelp may be formed into butt-welded pipe in a recently installed continuous butt-weld mill. This unit is designed to produce ½–3 in. pipe at speeds ranging 73–360 ft. per min. The installation follows the conventional design of units of this type, of which a considerable number have been recently put in throughout the steel industry. Bevel-edged skelp is uncoiled through a roller leveler, flash welder, and pinch rolls, and passes on through a furnace 147 ft. 3 in. long. The

PERRIN RULE, *General Superintendent*
South Chicago Plant

H. J. DARLINGTON, *Superintendent*
Open Hearth Department

P. V. CARNEY, *Superintendent*
Bessemer Department



The tandem cold reduction mill is driven by one 1500 hp. motor and four 1750 hp. motors, all of 600 volts d-c.

furnace is equipped with six recuperator chambers and three fans, and burns mixed gas. An average fuel consumption of about 5,000,000 Btu. per net ton charged is reported. After heating, the skelp passes through the customary air jets, six pairs, arranged in three sets, of forming and welding rolls, and a hot saw, and the welded pipe proceeds to a 72 ft. x 6 ft. 9 in. intermediate cooling rack. After next passing through descaler rolls, the pipe passes to a 72 ft. x 26 ft. 9 in. cooling rack. Production rates on this unit vary considerably with the size of the product, running from 33 tons per 8 hr. turn on ½ in. pipe, through 88 tons per turn on 1¼ in. pipe, and up to 114 tons per turn on 2 in. pipe.

In addition to the continuous pipe mill, one other butt-weld unit and two lap-weld units are available, giving a total capacity of about 140,000 tons per year of ⅜–3 in. butt-welded pipe, and 120,000 tons per year of 2⅜–8⅝in. lap-welded pipe. Pipe finishing equipment includes a galvanizing pot, as well as the necessary straighteners, testing machines, reaming and cut-off machines, etc.

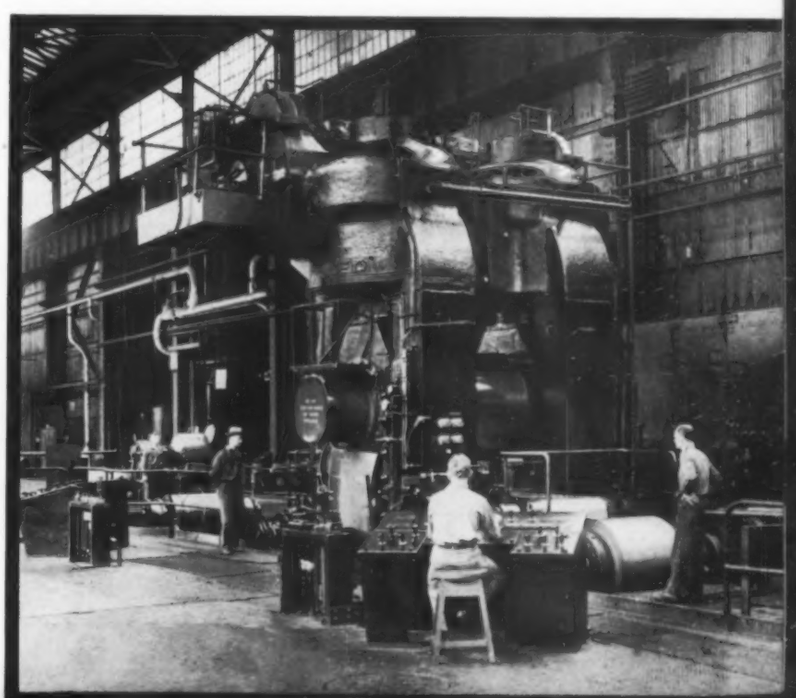
HOT STRIP MILL

An important unit in a recently completed modernization program is the 54 in. continuous strip mill, with its various auxiliary departments. This unit replaced the old style tin mills, and materially expanded the plant's flat-rolled capacity. The hot mill has a nominal capacity of 75,000 net tons of strip per month, rolling No. 18 gauge in 8–43 in. widths, No. 16 gauge in 8–45 in. widths, No. 14 gauge in 8–48 in. widths, and heavier material, up to ⅜ in. thick, in 8–51 in. widths. About 40 per cent of the product goes to hot finished material, and 60 per cent to tin plate.

Slabs, transported on railroad cars from the blooming mill, range 8–52½ in. wide x 3–5 in. thick x 65–180 in. long, and 1600–10,400 lb. in weight. They are unloaded in the slab yard, and there conditioned by manual scarfing. Cranes then move the slabs to hydraulically operated magazine elevator feeders, of which each furnace has two. Likewise, two pushers are provided for each furnace, which may be charged with either a single or double row of slabs. Slabs are centered on the charging skids by the action of a hydraulic centering device.

Two continuous slab heating furnaces are installed, each rated at 67 net tons per hour. The hearths are 18 ft. wide x 81 ft. 1½ in. long, 18 ft. of this length being a solid hearth soaking zone. The 9 in. flat suspended roof carries 2½ in. thickness of insulation except for a distance of about 20 ft. over the main heating zone. Hearth and sidewalls are well insulated, using in most

Two single-stand reversing mills, 16 and 49 in. x 42 in., provide additional cold reduction capacity of about 7000 tons per month.



G. W. ABEL, *Superintendent*
Blooming, Billet, Bar and Skelp Mills

cases composite insulation of varying thickness as dictated by the thermal considerations.

The main top heating zone, the bottom heating zone, and the soaking zone are each equipped with six combination burners for oil or mixed gas. In addition, about 27 ft. from the charging end, there are four auxiliary burners (one top and bottom on each side), slanted toward the back end of the furnace. The furnace roof is raised somewhat at this point. This auxiliary firing raises the maximum furnace capacity by about 35 per cent above the nominal rating when so desired. Oil is the fuel in present use, with an average consumption of about 14 gal. per ton on an average production of 62.5 tons per furnace hour.

Air for combustion is furnished to each furnace by two fans rated at 50,000 cu. ft. per min. at 3 in. water column, 750 degrees F., and one 2500 cu. ft., 8 in. blower. The air is preheated by a double unit, two-pass carborundum tube recuperator located under the furnace hearth. The furnace is provided with automatic control equipment operating on fuel-air ratio, furnace pressure, and temperature.

The hot mill is placed close to the heating furnaces, with the roughing scale-breaker only 29 ft. 2 in. from the center-line of the nearest furnace. This scale-breaker is of the vertical type, with rolls 40 in. diameter x 8¼ in. body length, and is driven by two 300 hp., 508 rpm., 2200 volt induction motors. It is followed at a distance of 27 ft. 10 in. by a two-high 40 in. x 56 in. rougher, driven by a 3000 hp., 144 rpm., 2200 volt synchronous motor. Due to the fact that the blooming mill furnishes slabs in widths up to the maximum rolled on the strip mill, no broadside rolling is performed, and the conventional turn tables, pusher and squeezer are unnecessary in this case. The roughing train is completed by three four-high stands, the first of 24½ in. and 45 in. x 54 in., and the other two of 22½ in. and 45 in. x 54 in., on successive spacings of 39 ft. 9 in., 55 ft. 6 in., and 82 ft. 6 in. These stands are driven by three 2500 hp., 2200 volt induction motors, the first running at 234 rpm., and the other two at 252 rpm.

Integral vertical edgers are provided on the three four-high roughers, using 20 in. diameter rolls driven by 150 hp., 460–1150 rpm., 230 volt d-c. motors.

A space of 132 ft. 3 in. separates the roughing and finishing trains, and is spanned by the delay table, in which is installed a rotary crop shear driven by a 75 hp., 515–1030 rpm., 230 volt d-c. motor.

The finishing train is composed of a two-high 25½ in. x 56 in. scalebreaker, followed at a distance of 14 ft. 8 in. by the six four-high, 22½ in. and 45 in. x 54 in. finishing stands on 18 ft. centers. The scalebreaker is driven by a 500 hp., 150–600 rpm., 600 volt d-c. motor. Five 3000 hp., 200–400 rpm., 600 volt d-c. motors are applied to the first five finishers, while the last stand uses a 2000 hp., 230–460 rpm., 600 volt d-c. motor.

Five loopers, operated by 200 lb. ft. torque motors, are installed between the six finishing stands, and serve to control any slack occurring in the strip between stands. An idler roll in each looper takes the place of any table rolls between stands.

Roller bearings are applied to the vertical scale breaker rolls and to the work rolls of the four-high stands. Oil-film bearings are used on the roll necks of the two-high rougher, the finishing scalebreaker, and the back-up rolls of the four-high mills. Rolls are hydraulically balanced, cylinders and rams in the top work-roll chocks holding the top back-up rolls against the mill screws, while cylinders and rams in the bottom work-roll chocks hold the top work rolls against the top back-up rolls.

Hot mill lubrication is effectively provided by automatic oil and grease systems. One 18,000 gal., 265 gal. per min. circulating oil system serves the back-up roll bearings, one 10,000 gal., 265. gal per min. system is applied to the reduction gears and their bearings, and

F. A. SCHUESSLER, *Superintendent*
Merchant Mills

an 8000 gal., 265 gal. per min. system is used on the pinions and their bearings. The vertical edger is supplied from a separate 2000 gal. system. One automatic pressure grease system serves the work rolls, table rollers, flying shear, screwdowns, crop shear, etc., while another system supplies the runout rollers, coilers, pilers, etc. These various systems are installed in a series of oil cellars under the hot mill floor, and in a grease pump house and oil filter house conveniently located on the hot mill floor.

Screwdowns in the hot mill are driven by the following motors:

	Number	Hp.	Rpm.
Vertical scalebreaker	2	50	550
Two-high rougher	1	35	575
Edger	1	15	725
No. 2 Rougher	2	35	575
Edger	1	15	725
No. 3 Rougher	2	35	575
Edger	1	15	725
No. 4 Rougher	2	35	575
Finishing scalebreaker	1	15	725
No. 5, 6, 7, 8, 9 and 10 finishers, each	2	35	575

All of these motors are 230 volt, d-c. units, compound wound. Magnetic clutches are installed in the operating mechanisms so that both screws of a mill may be operated individually or in unison.

To insure a high quality of strip surface, hydraulic descaling sprays are placed, top and bottom, at the exit of the roughing scalebreaker; top only, exits of No. 2 and No. 3 roughers; a double spray, top and bottom, at the exit side of the finishing scalebreaker. The sprays are controlled by means of electrical solenoid actuated, air-operated valves, and water is supplied by two 1000 gal. per min., 1150 lb. centrifugal pumps, each driven by a 1000 hp., 3550 rpm., 2200 volt induction motor. When all sprays are shut off, relays in the power circuit of the pump drives actuate thrustors which open by-passes around the pumps to prevent their over-heating. Steam jets are also installed at the entrances to the roughing scalebreaker and all finishing stands.

Gear ratios and mill speeds in the hot mill are as follows:

Stand	Motor rpm.	Gear ratio	Roll rpm.	Roll speed, ft. per min.
No. 1 scalebreaker	508	28.57	17.78	186
No. 1 rougher	144	7.8	18.46	193
Edger	450/900	15.25	29.51/59.02	154.5/309.
No. 2 rougher	234	5.111	45.78	294
Edger	450/900	11.6	38.79/77.59	203/406
No. 3 rougher	252	4.238	59.46	350
Edger	450/900	11.6	38.79/77.59	203/406
No. 4 rougher	252	4.238	59.46	350
No. 2 scalebreaker	150/600	8.810	17.02/68.11	114/455
No. 5 finisher	200/400	5.111	39.13/78.26	231/461
No. 6 finisher	200/400	2.906	68.8/137.6	405/810
No. 7 finisher	200/400	1.976	101.2/202.4	596/1192
No. 8 finisher	200/400	1.551	128.95/257.9	760/1519
No. 9 finisher	200/400	1.315	152.1/304.2	896/1791
No. 10 finisher	230/460	1.316	174.8/349.6	1030/2059

Slabs normally average about 4½ in. in thickness, and the reduction schedules are usually such that the slab leaves the four roughers at thicknesses of 3¼ in., 2 in., 1¼ in., and ¾ in., respectively. Typical finishing train reductions are then 40, 35, 30, 30, 25 and 10 per cent, respectively, in the six finishing stands. The mill averages a production of 125 tons per hour, and has reached rates as high as 185 tons per hour.

A rotary flying shear is installed at a distance of 11 ft. 9 in. from the last finishing stand. It is designed for

The two-stand temper mill, also provided with separate tension rolls, attains a maximum delivery speed of 2030 ft. per min.

E. L. APPLEGATE, *Superintendent*,
Tube Mills

lengths ranging from 14 ft. to 56 ft., and is driven by two 150 hp., 460 rpm., 230 volt d-c. motors.

From the flying shear, the runout table extends about 425 ft. to two downcoilers, each driven by eight 15 hp., 1200 rpm., 230 volt d-c. motors. Coils of No. 9 to No. 20 gauge material, 25 in. inside diameter x 48 in. outside diameter, 12,000 lb. maximum weight, may be formed at speeds up to 2180 ft. per min. The runout table is divided into four control sections, totaling 134 rollers, each driven by an individual 4 hp., 750 rpm., 230 volt motor. A maximum table speed of 2035 ft. per min. is attained. When cut lengths are being rolled, eighteen more rollers, driven by eight 3 hp., 525 rpm. motors and ten 4 hp., 750 rpm. motors, all 230 volts d-c., convey the material to a piler at the end of the table. Variable voltage control is used for these table drives.

A departure from the conventional layout of mills of this type is the installation of a vertical coiler which may be used instead of the down coilers. Immediately following the flying shear there is a transfer car with a 10 ft. lateral travel. On this car, with centerlines spaced at 10 ft., are the first 45 ft. of runout table and a set of horizontal and vertical feed rollers and guides through which the strip may be diverted to the vertical coiler. Either of these may be lined up with the mill line by the movement of the car. When the vertical coiler is in use, the strip passes through the horizontal feed rollers, and is guided through two sets of vertical feed rollers, all with operating speeds of 735–2205 ft. per min. Following the second set of vertical rollers, vibrator arms, operating in a range of 60–180 oscillations per min., form a series of serpentine waves in the strip as it passes over an apron conveyor with an operating speed of 93–280 ft. per min. This apron conveyor extends at an angle with the mill line, and leads to the vertical coiler, which is designed to handle No. 10–20 gauge material, 8–44 in. wide, forming coils 25 in. inside diameter, 30–48 in. outside diameter, and 7000 lb. maximum weight. It is driven at speeds up to 356 rpm. by a 100 hp., 475–1425 rpm., 230 volt d-c. motor. It is preceded by a pair of vertical feed rollers operating at speeds up to 256 ft. per min., and a vertical crop shear capable of 30 cuts per min.

Coils from all of the coilers are conveyed to a long coil conveyor which runs almost the entire length of the coil storage building, adjacent to the runout building.

One end of the hot mill building, near the slab heating furnaces, is devoted to a roll shop. Included here are 34 in. and 60 in. roll lathes, and three roll grinders, one 50 in. x 16 ft., one 30 in. x 12 ft., and one 30 in. x 10 ft.

J. C. GRIFFIN, *Manager*
Strip and Tin Plate Department

HOT MILL MOTOR ROOM

The hot mill motor room occupies its conventional location between the slab yard and the hot mill building, and houses all main hot mill drives, with their reduction gear sets, control equipment, switchgear, etc. Roughing mill motors use reactor and secondary resistance starting, while finishing train motors operate under Ward-Leonard control. These d-c. motors receive power from two dual motor-generator sets, each consisting of two 3000 kw., 600 volt d-c. generators and one 8400 hp., 360 rpm., 11,000 volt synchronous motor.

Also housed here are the motor-generator sets which supply power to the loopers, runout table, and coilers, which, as is evident from their previous description, operate on the more recent d-c. system rather than the more common variable frequency system. The set serving the loopers and the delay table consists of one 25 kw., 50 volt generator and two 60 kw., 250 volt generators, driven at 1160 rpm. by a 225 hp., 440 volt induction motor. Runout table and coilers are served by a unit including three 200 kw. generators, two 100 kw. generators, and one 50 kw. generator, all of 250 volts, and driven by a 900 hp., 1200 rpm., 2300 volt synchronous motor. The hot mill exciter set includes three 250 volt generators, of 200, 100, and 40 kw., respectively driven by a 450 hp., 2300 volt. synchronous motor.

Lower voltages for the hot mill are provided by a 10,000 kva., 11,000/2300 volt transformer bank and a 1500 kva., 11,000/440 volt three-phase transformer, both located in the motor room.

Electrical machinery is cooled by a closed recirculating system, in which air is cooled in surface type coolers and blown into the motor room, which is thus kept under a slight pressure. Air passes down through the machines and back to the coolers. A total circulation of 385,000 cu. ft. per min. is afforded by ten fans, while a makeup capacity of 40,000 cu. ft. per min. is provided by two fans and two air filters. The air coolers require a water flow of about 2200 gal. per min., the greater part of which is first passed through a battery of four horizontal filters and subsequently reused in the hydraulic descaling system.

Power is brought to the hot mill motor room at 11,000 volts either from the plant power house or from the merchant mill substation. Metal clad switchgear is used,

J. S. HOGUE, *Superintendent*
Strip and Tin Plate Department

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C. A. MITCHELTREE, *Superintendent of Cold Strip Mills,* and T. G. SIMISON, *Superintendent of Hot Strip Mills*

and all 11,000 volt breakers are rated at 1200 amp., 500,000 kva. rupturing capacity. The entire hot mill is served from this station, and two 11,000 volt circuits feed out to the cold mill and tin mill substations. The basic connected load of the strip plant is as follows:

	kva.
Transformer bank, 11,000/2300 volts, (roughing stands, pumps, etc.)	10,000
Finishing train motor-generator sets—2 x 8400 hp. x .746	12,520
Auxiliary motor-generator set—2200 hp. x .746	1,640
Transformer bank, 11,000/440 volts (hot mill)	1,500
Tandem cold mill motor generator set	7,500
Reversing mill motor generator set	2,100
Reversing mill motor generator set	3,000
Transformer bank, 11,000/2300 volts (hot finishing, etc.)	3,750
Transformer bank, 11,000/2300 volts (hot finishing, etc.)	3,750
Transformer bank, 11,000/440 volts (tin mills, etc.)	1,500
Transformer bank, 11,000/440 volts (cold mills)	2,000
Transformer bank, 11,000/440 volts (cold mills)	1,000
Skin pass motor generator set	1,500
Skin pass motor generator set	2,250
Total, 11,000 volt connected load	54,010

HOT FINISHING

The conventional equipment for hot finishing is installed in a large building paralleling the hot mill building. A four-arm vertical plunger pickler, for cut lengths up to 17 ft., is served by a circular turntable for loading and unloading. The pickled sheets are then passed through a scrubbing, drying, and oiling line.

Two temper mills are installed in this department. A 28 in. x 54 in. two-high unit is equipped to roll either sheets or coils. Driven by a 200 hp., 500–1000 rpm., 230 volt d-c. motor through a gear ratio of 10.6 : 1, a mill speed of 47.2–94.4 rpm., or 367–734 ft. per min. is obtained. The reel is driven by a 200 hp., 300–900 rpm., 230 volt motor. The motor generator serving this mill consists of one 150 kw., 250 volt generator, one 200 kw., 250 volt generator, and one 10 kw., 250 volt exciter, driven by a 700 hp., 1200 rpm., 2200 volt synchronous motor. A four-high roller leveler follows the mill.

The other temper mill is a two-high 28 in. x 60 in. mill, for rolling cut lengths only. This mill is driven by a 150 hp., 1200 rpm., 2200 volt motor through a gear ratio of 40.324 : 1, giving a mill speed of 29.76 rpm., or 218 ft. per min. A four-high roller leveler is also installed on the exit side of this mill.

A coil processing line, designed to produce cut lengths 30 in. to 20 ft. long from coils 8–51 in. wide and No. 9–20 gauge, is also provided. This unit, operating at 100–300 ft. per min. when shearing, and up to 500 ft. per min. when recoiling, consists of a processor and pay-off reel, slitter and scrap chopper, tension recoiler, flying shear, belt conveyor, and piler. Material may therefore be put through this line for almost any combination of processing, including side trimming, leveling, or slitting, and may be cut to length or put back into coil form.

Besides miscellaneous resquaring shears, levelers, etc., this department also includes two plate shearing units, consisting of a leveler, side trimmer and scrap chopper, an up-cut shear and gauge, and another leveler. One

unit is designed for material in thicknesses up to 5/16 in., cutting lengths of 30 in. to 23 ft., while the other cuts lengths of 30 in. to 32 ft., in thicknesses up to 3/8 in.

Cut lengths are conveyed to the hot finishing department over a sheet pack transfer, while coils are brought from the raw coil storage through a conveyor tunnel which passes under the hot mill runout.

CONTINUOUS PICKLING

Two continuous pickling lines, one for 38 in. material, the other for 51 in. material, prepare the strip for subsequent cold reduction. Space for a third line is available. From the coil storage, coils pass over conveyors to the head of the pickling lines, where they are upended and placed in the uncoilers. Strip next passes through the usual crop shear, stitcher, pinch rolls, looping pit, and master pinch rolls. The 38 in. line also has a flash welder and trimmer preceding the stitcher. Both lines are designed for maximum coils of 48 in. outside diameter, 12,000 lb. weight at the entry ends, and 60 in. outside diameter, 25,000 lb. weight at the exit ends.

Each line contains four acid tanks and two rinse tanks. Acid tanks in the 38 in. line are 60 ft. long, 4 ft. 1½ in. wide, and 3 ft. 9½ in. deep, with a capacity of 5600 gal., while in the larger line, the acid tanks are 60 ft. x 4 ft. 4 in. x 4 ft., with 8000 gal. capacity. They are of steel construction, rubber and brick lined, with rubber lined steel covers. Rinse tanks are 25 ft. long, of steel plate construction. Tanks are connected to a common vent system, from which a fan removes fumes to the outside through rubber lined flues.

Solutions are heated by steam, the temperature being automatically maintained at about 200 degrees F. The cascade system of pickling is used, the second, third and fourth tanks being dumped back into the first tank as the solution becomes inactive. Solutions are kept at 15 per cent of sulphuric acid in the second tank, and 12 per cent in the third and fourth tanks. The first tank is killed when it drops to 7 per cent acid. Two storage tanks provide a supply of hot water for use in the tanks of the pickling lines as desired.

The lines operate in a speed range through the tanks of 60–240 ft. per min., with the head end operating at 200–400 ft. per min., and the exit end at 75–300 ft. per min. Production rates of 25 to 35 tons per line per hour are maintained. The material pickled is normally No. 14 gauge, and shows a pickling loss of 1¼ per cent.

COLD MILLS

From the exit ends of the picklers, coils are conveyed across the end of the raw coil storage building to the pickled coil storage, from where they are taken to the cold mills. Cold reduction facilities consist of one five-stand tandem mill and two single stand reversing mills.

The tandem mill is an 18 in. and 49 in. x 48 in. unit, with the stands spaced on 13 ft. centers. The drives are one 1500 hp., 300–600 rpm. motor, three 1750 hp., 300–600 rpm. motors and one 1750 hp., 175–437 rpm. motor, all of 600 volts d-c. Gear ratios and mill speeds are as follows:

Stand	Motor rpm.	Gear ratio	Roll rpm.	Roll speed, ft. per min.
1.....	300/600	5.88	51/102	240/480
2.....	300/600	3.95	76/152	360/720
3.....	300/600	2.62	114.5/229	540/1080
4.....	300/600	1.89	159/318	748/1496
5.....	175/437	Direct	175/437	825/2059

The reel, 20 in. in diameter, is driven through a gear reduction of 2.85 : 1 ratio by a 400 hp., 300–1200 rpm., 600 volt d-c. motor.

Mill screws on each stand are driven by two 35 hp., 575 rpm., 230 volt d-c. motors.

The five main drive motors and the reel motor operate under Ward-Leonard control, receiving power from a

Twenty tin pots, five of 75 in. width and fifteen of 64 in. width, average a production of 11 tons per turn, each.

W. D. CLEAVENGER, *Superintendent*
Mechanical Department

motor generator set composed of two 2500 kw., 600 volt generators, one 350 kw., 600 volt generator for the reel, and one 125 kw., 250 volt exciter, all driven at 514 rpm. by a 9000 hp., 11,000 volt synchronous motor. This set, together with the mill drives and their switchgear, is located in a motor room provided with a recirculating capacity of 144,000 cu. ft. per min. and a filtered makeup of 14,500 cu. ft. per min.

This mill averages about 35 tons per hr. production, and has established an 8-hr. turn record of 453½ tons, and a monthly figure of 19,343 tons.

No. 1 reversing mill is a 16½ in. and 49 in. x 42 in. unit, driven through a gear set of 1.454 : 1 ratio by a 2000 hp., 230–350 rpm., 600 volt d-c. motor, giving a roll speed of 158–240 rpm., or 683–1034 ft. per min. A motor generator set, consisting of one 2000 kw., 600 volt generator, one 200 kw., 300 volt booster, one 50 kw., 250 volt exciter, and a 3000 kva., 514 rpm., 11,000 volt synchronous motor, serves this mill. The two reels, 30 in. x 46 in., are driven by 600 hp., 250–875 rpm., 600 volt d-c. motors, through a gear ratio of 5.9 : 1.

No. 2 reversing mill, 16 in. and 49 in. x 42 in., is driven by a 1750 hp., 400–600 rpm., 600 volt motor. A gear reduction of 2.15 : 1 gives a roll speed of 186–279 rpm., or 804–1205 ft. per min. Two 500 hp., 250–875 rpm., 600 volt motors drive the reels, through a gear reduction of 4.96 : 1 ratio. This unit receives power from a motor generator set composed of one 1500 kw., 600 volt generator, one 150 kw., 350 volt booster generator, and one 75 kw., 250 volt exciter, driven by a 2100 kva., 514 rpm., 11,000 volt synchronous motor.

The screwdowns of each reversing mill are driven by two 50 hp., 500 rpm., 230 volt d-c. motors.

The reversing mills each average about 5 tons per hour although turn records of 76 and 101 tons have been established.

All of the cold reduction mills are equipped with roller bearings on the work rolls and oil film bearings on the back-up rolls. Automatic gaugers and strip tension indicators are provided on all mills. The drives and motor generator sets for both reversing mills are located in separate motor rooms with forced circulation cooling and ventilation.

The five-stand tandem mill is lubricated by a grease system on work roll bearings, etc., a 10,000 gal., 117 gal. per min. oiling system on the back-up roll bearings, and a 2000 gal., 60 gal. per min. system on the reduction gears and their bearings. One oiling system and two grease systems provide lubrication for both reversing mills.

A total departmental capacity of about 27,000 tons per month is offered. Most of the product is reduced to tin plate gauges from a hot rolled gauge of .062–.085 in.

Cold mill rolls are kept in condition by a 54 in. x 240 in. roll grinder and a 24 in. x 144 in. roll grinder installed in the cold mill building. A grit blasting apparatus is also provided for roll preparation.

After cold reduction, the strip is electrolytically cleaned to remove all oil remaining from the rolling process. Three cleaning lines of conventional design are installed, one for coils 44 in. in diameter x 38 in. wide, with a speed of 750 ft. per min., and two for coils 48 in. in diameter x 38 in. wide, with a speed of 940 ft. per min. In each line is incorporated the usual uncoiler, electrical lap welder, washer, electrolytic cleaner, scrubber, rinse tank, dryer, pinch rolls, and winding reel. These lines provide a total capacity of about 300 tons per 8 hr. turn.

BOX ANNEALING

A total annealing capacity of about 24,000 tons per month is afforded by a battery of twelve two-chamber in-and-out box annealing furnaces, for coil annealing, and two four-chamber furnaces, for either sheets or coils. The former chambers are 21 ft. 6 in. long x 8 ft. 6 in. wide, and take a charge of about 40 tons. The latter furnaces are larger, 27 ft. 6 in. long x 13 ft. 6 in. wide, and take charges up to 80 tons. All of the fur-

G. E. ADAMS, *Superintendent*
Electrical Department

naces are fired with mixed gas through luminous burners, using about 2,000,000 Btu. per net ton annealed. Annealing temperatures, which are automatically controlled, normally run 1280–1350 degrees F., and a 40 hour heating and soaking cycle is usual. About 98 per cent of the material annealed is in coil form. Three 8000 cu. ft. per hr. gas preparation machines provide the gaseous atmosphere necessary for bright annealing. The furnaces are served by floor-type chargers.

SKIN PASS MILLS

The annealed strip is next flattened and tempered to the desired degree by rolling in the skin pass mills. Two units are available for this purpose. The older mill is a single stand unit, while the recently installed mill consists of two stands in tandem, all 18 in. and 49 in. x 42 in.

The single stand mill is driven by a 300 hp., 230 volt, 575–1150 rpm., d-c. motor. Two 15 kw. drag generators are applied to the entry reel, and one 102 kw. drag generator to the entry tension rolls. Exit tension rolls 42 in. long x 20 in. diameter, are driven by a 300 hp., 575–1150 rpm. motor, and the 20 in. winding reel by a 150 hp., 300–1200 rpm. motor. The motor generator set on this mill consists of two 500 kw., 250 volt generators and a 25 kw., 250 volt exciter driven at 900 rpm. by a 1500 kva., 11,000 volt synchronous motor.

Main drives of the two-stand mill are two 350 hp., 215–430 rpm., 230 volt d-c. motors. Two 25 kw., 125 volt drag generators are used on the entry reel and one 102 kw. machine on the entry tension rolls. A single 350 hp., 215–430 rpm. motor drives the exit tension rolls, and a 150 hp., 95–380 rpm. motor is applied to the winding reel. This mill is served by a motor generator set composed of three 500 kw., 250 volt generators and a 50 kw. exciter, driven by a 2250 kva., 900 rpm., 11,000 volt synchronous motor.

	Motor rpm.	Gear ratio	Roll rpm.	Roll speed, ft. per min.
Single stand....	575/1150	3.5	164/328	774/1548
Tandem mill...	215/430	Direct	215/430	1015/2030
Tandem mill...	215/430	Direct	215/430	1015/2030

Mill speeds and gear ratios in these units are as follows:

All work rolls operate in roller bearings with oil-film bearings on the back-up rolls. Each mill is provided with an automatic grease system, while one oiling system serves both mills.

Maximum turns of 170 tons and 253 tons, respectively, have been recorded.

Five shearing lines, two for widths up to 72 in. and three for widths up to 42 in., cut up the coils into black plate 18–39 in. long. These lines operate at 450 ft. per min., and have a capacity of 7½ tons per machine hour. The plate is then white pickled, two batch type picklers being used for the purpose, after which the plate is kept in water-filled boshes until brought to the tinning lines. Twenty tin pots are installed, five of 75 in. width, and fifteen of 64 in. width. Production from these machines averages about 11 tons per pot per 8 hr. turn. Under construction is an extension for four more pots, which are to be heated by immersion burners using premixed gas and air. From the tin house the material is taken to the assorting room and warehouse, where it is inspected, boxed, and stored for shipment.

Located near the shearing lines are six three-stand tandem trains of conventional two-high cold mills, driven by a 1000 hp., 240 rpm., 2200 volt motor. These mills are used for miscellaneous processing and salvage work.

Throughout the finishing departments of the strip mill, material handling relies heavily on electric trucks. A total of 32 of these machines, of various types, ranging from 3800 lb. to 14,000 lb. in capacity, are used.

MISCELLANEOUS SERVICES

Power for the entire plant is furnished at 60 cycles from the company's powerhouse and a tie with the local utility company. Generating equipment includes two 5000 kw. and two 10,000 kw. turbo-generators, 2300 volts, operating on 185 lb. steam pressure and equipped with jet condensers. Recent additions to plant load brought the installation of one 10,000 kw., 11,000 volt topping unit, operating on 800 lb. pressure and exhausting into the 200 lb. system.

The utility lines come in to an outdoor substation near the merchant mills, at 33,000 volts. Two banks of 33,000/11,000 volt transformers, one of 20,000 kva. and one of 6000 kva., step down the voltage before it enters the indoor station. This indoor station is connected to the 11,000 volt bus in the power house, to the hot strip motor room, and to the merchant mill motor room. The entire strip plant operates from the 11,000 volt system, being fed from the 11,000 volt bus in the power house, or from the merchant mill substation. Thus, a loop system is available, offering a high degree of flexibility and protection. The 11,000 volt system is tied in to the 2300 volt system at the powerhouse through one 7500 kva. bank and one 10,000 kva. bank of transformers, 11,000/2300 volts. Distribution to the remaining parts of the plant is at 2300 volts.

To supply steam to the topping turbine, two 140,000 lb. per hr. units have been recently installed. Operating at 825 lb. and 750 degrees F., they are fired with pulverized coal. A complete system of automatic control is provided for these boilers. Air for combustion is heated to about 500 degrees F. in tubular type air heaters. Steam passes through the topping turbine and into the 200 lb. system, loads of 282,000 lb. per hr. being encountered. A reducing valve connection also joins the two systems. The 200 lb. system is also fed from three 800 hp. and six 600 hp. bent tube boilers fired with blast furnace gas, eight 600 hp. bent tube-boilers fired with gas or coal, four 600 hp. bent water tube waste heat boilers, and four 750 hp. horizontal fire tube waste heat boilers. All of these operate at 200 lb., 520 degrees F., and carry a load of about 320,000 lb. per hr. This steam is used in the blast furnace blowers, the bessemer blowers, the low pressure turbo-generators, and miscellaneous plant usage.

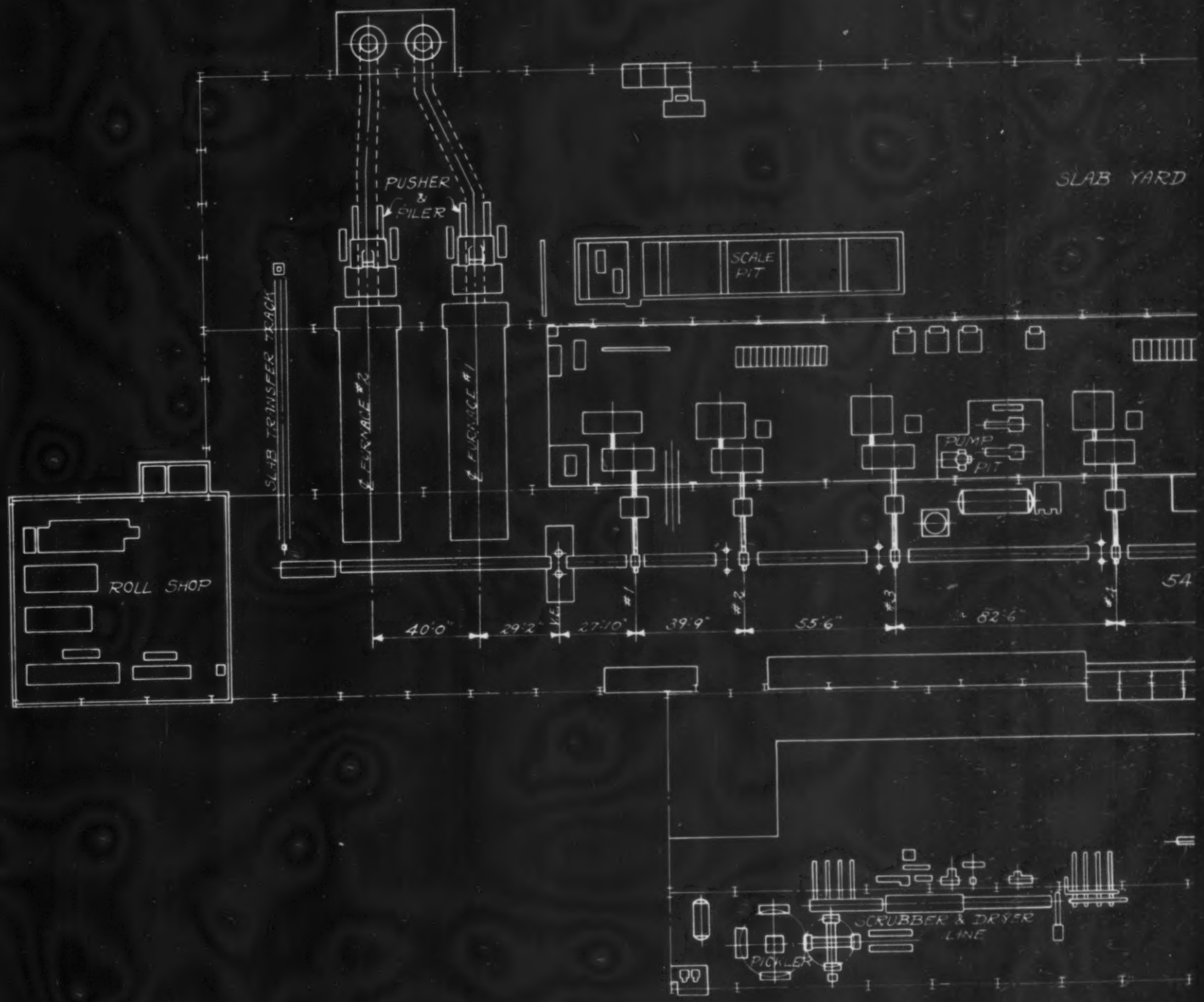
All of these boilers are fed from a new continuous lime-soda-zeolite softening plant. In this plant, which is designed for 1,000,000 lb. per hour, preliminary lime-soda softening, coagulation and filtering is followed by zeolite softeners. Deaeration and internal phosphate treatment complete the process.

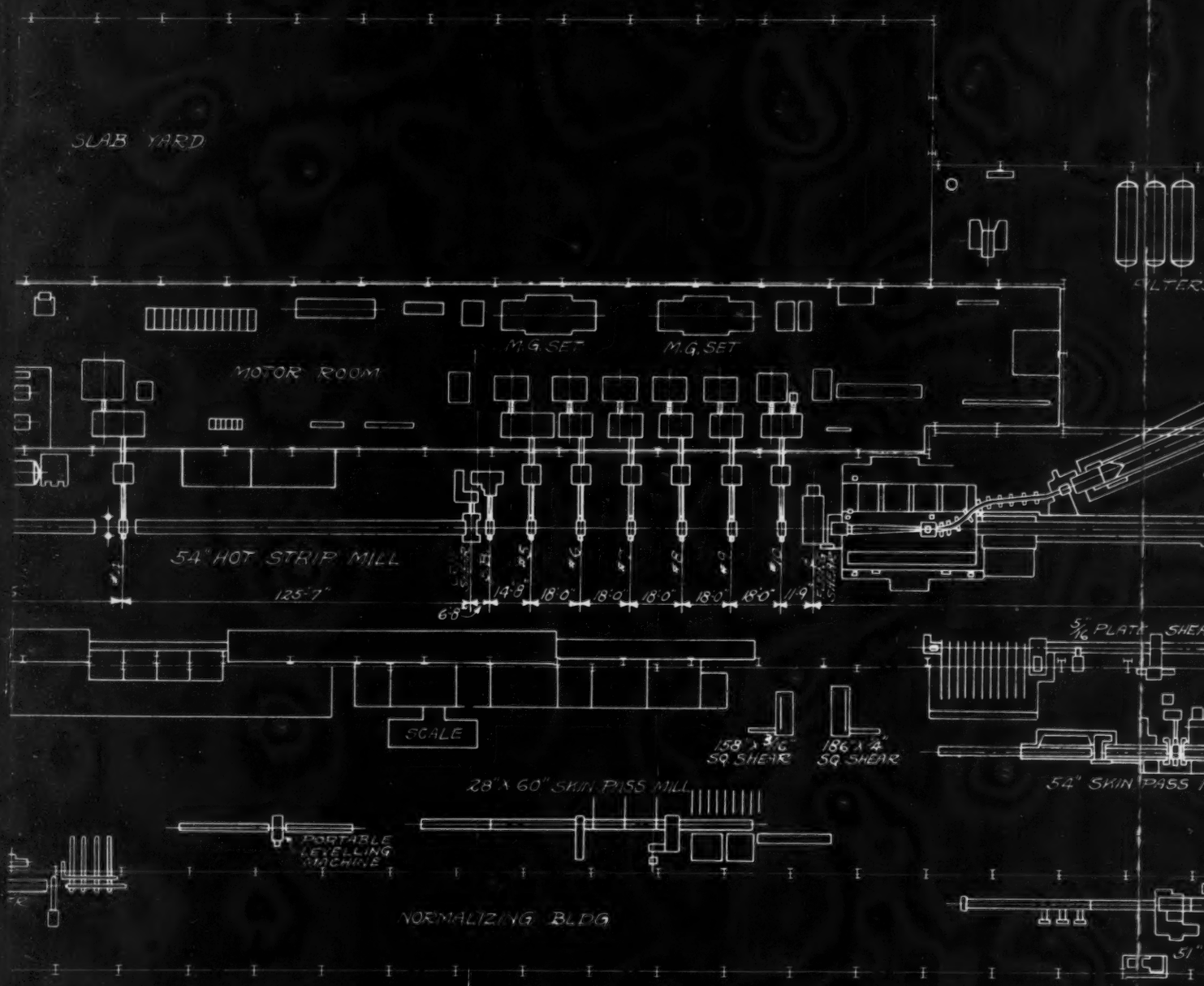
Indiana Harbor Plant

YOUNGSTOWN SHEET & TUBE COMPANY

STEEL PLANT
HOT BED BLDG
POWER HOUSE
BOILER HOUSE
BLAST FURNACE
ORE DOCK
SINTER PLANT
CANAL

STEEL PLANT
LAKE MICHIGAN
CANAL
PUMP HOUSE
WATER INTAKE
ORE DOCK
HOT BED BLDG.
POWER HOUSE
BOILER HOUSE
WAREHOUSE
#4 & #5 BUTT WELD
#1 LAP WELD
#2 LAP WELD
#3 LAP WELD
TIN PLATE DEPT.
BRIDGE SHOP
PIPE MILL
GAS PRODUCERS
BLAST FURNACES
SLAG PITS
SCALE PIT
SINTER PLANT
ORE BRIDGE
ORE UNLOADER
SOFT BREAKWATER
SLIP
SCRAP YARD
SCRAP YARD
SCRAP YARD

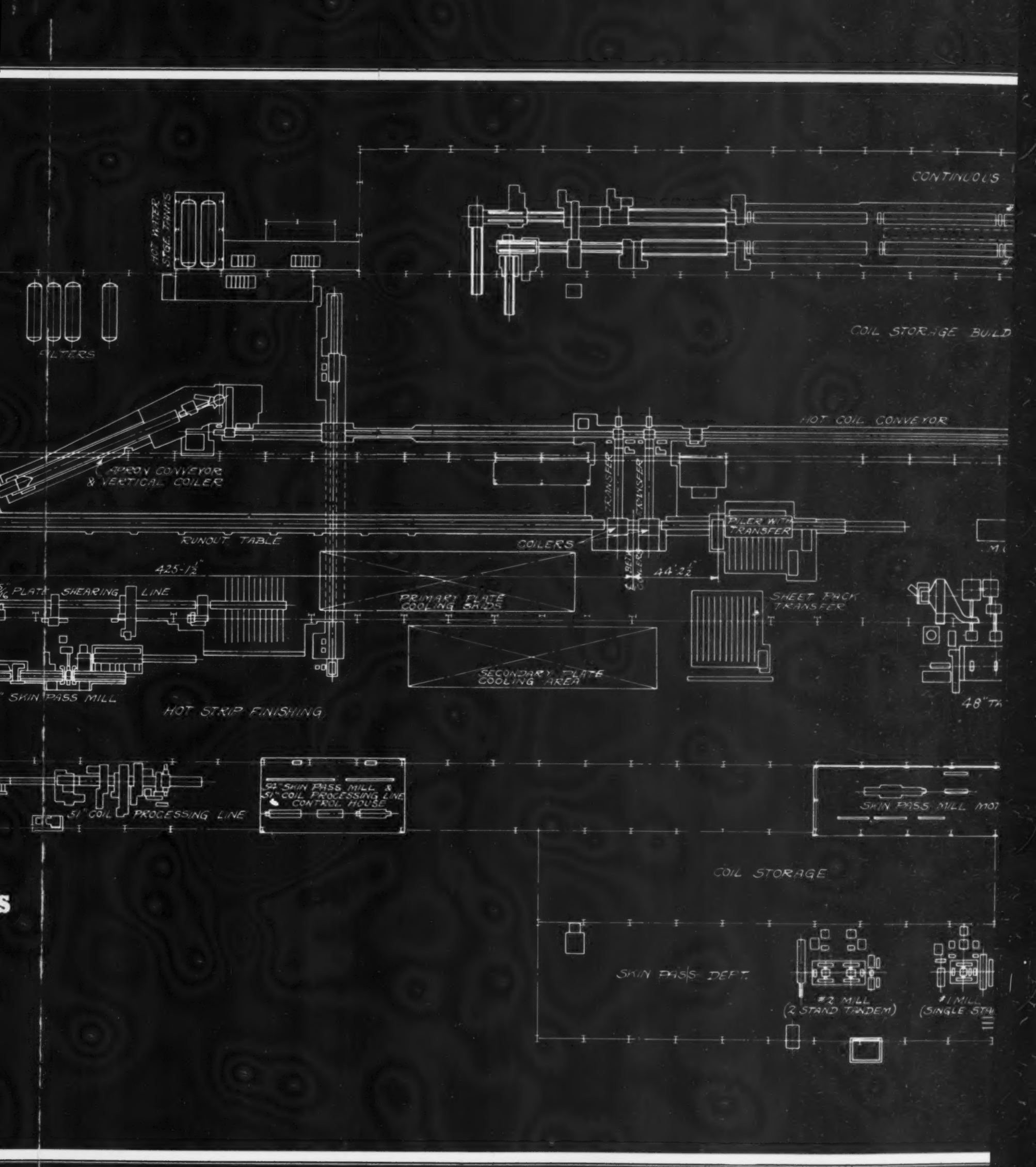

SLAB YARD
PUSHER & PILER
SCALE PIT
SLAB TRANSFER TRACK
FURNACE #2
FURNACE #1
PUMP PIT
ROLL SHOP
54
40'0"
29'2"
27'10"
39'9"
55'6"
82'6"
#1
#2
#3
#4
SCRUBBER & DRYER LINE
PICKLER
SCALE
0 10 20 30 40 50

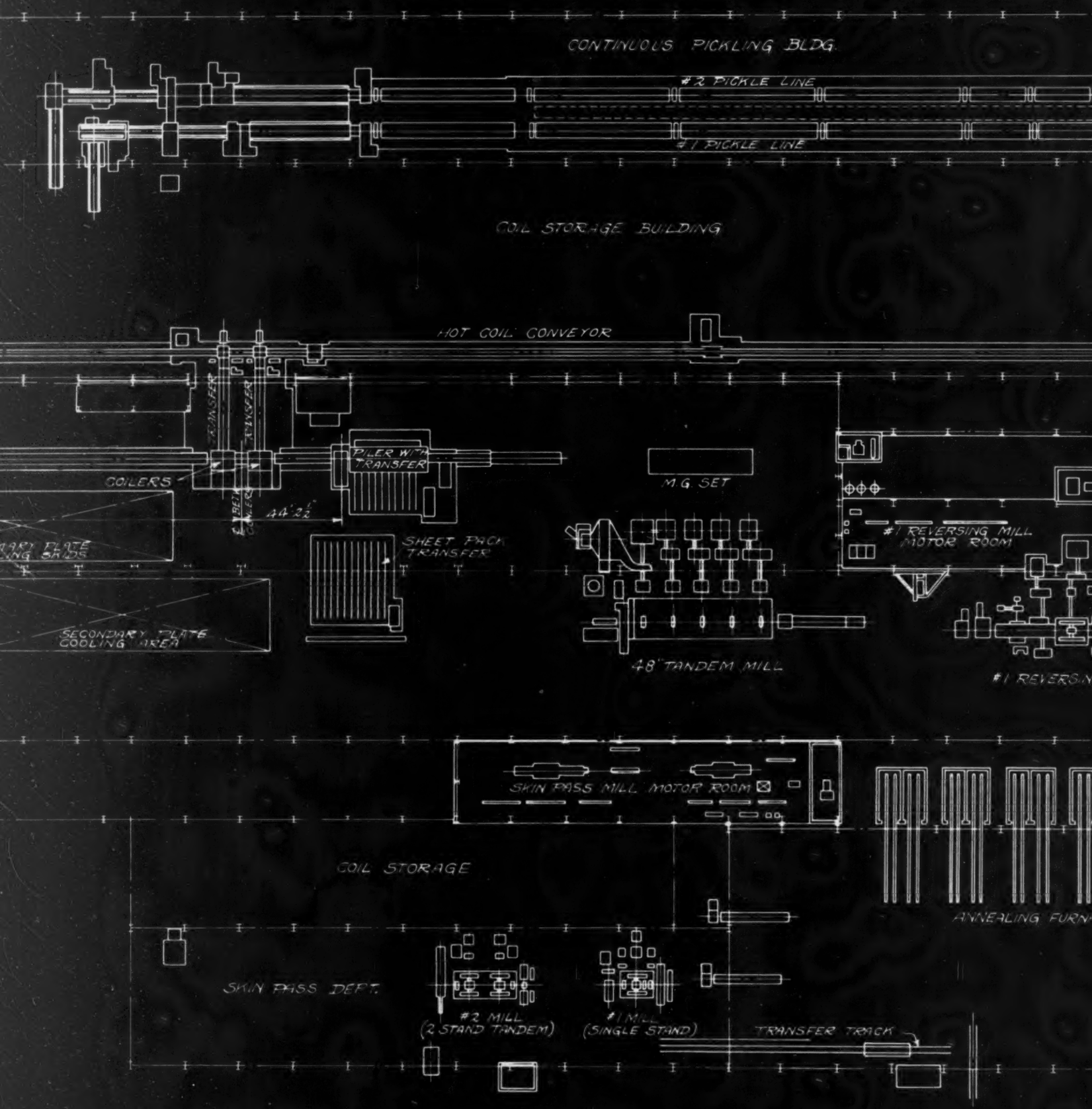


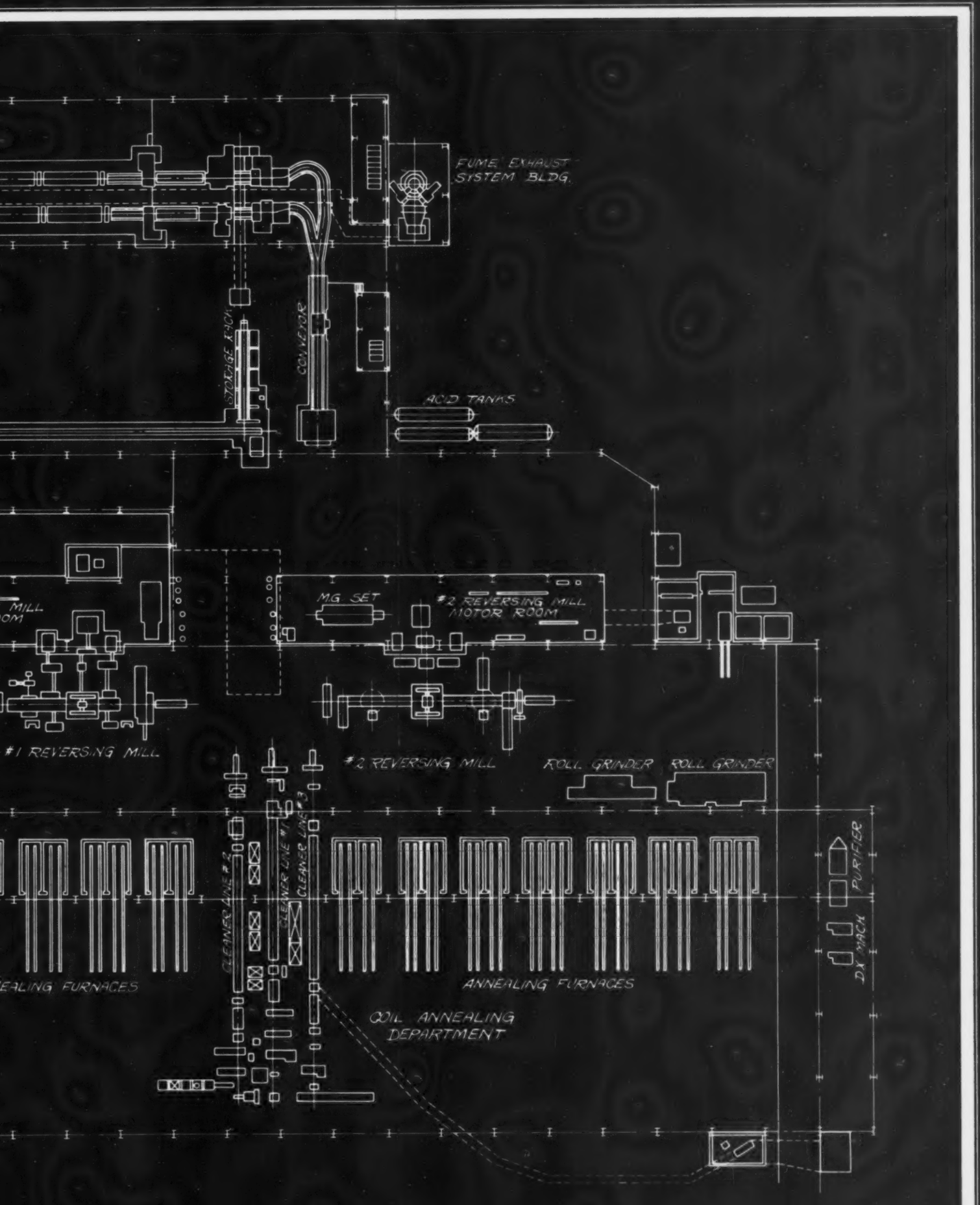
HOT AND COLD STRIP MILLS

YOUNGSTOWN SHEET & TUBE COMPANY

Indiana Harbor Plant


HOT WATER STGE TANKS
CONTINUOUS
FILTERS
COIL STORAGE BUILD
HOT COIL CONVEYOR
APRON CONVEYOR & VERTICAL COILER
TRANSFER
TRANSFER
PILER WITH TRANSFER
RUNOUT TABLE
COILERS
425-1½"
44'2½"
PRIMARY PLATE COOLING BEDS
SHEET PACK TRANSFER
SHEARING LINE
SECONDARY PLATE COOLING AREA
SKIN PASS MILL
HOT STRIP FINISHING
48" TA
92" SKIN PASS MILL & 51" COIL PROCESSING LINE CONTROL HOUSE
51" COIL PROCESSING LINE
SKIN PASS MILL MOT
COIL STORAGE
SKIN PASS DEPT.
#2 MILL (2 STAND TANDEM)
#1 MILL (SINGLE STA


CONTINUOUS PICKLING BLDG.
#2 PICKLE LINE
#1 PICKLE LINE
COIL STORAGE BUILDING
HOT COIL CONVEYOR
TRANSFER
TRANSFER
PILER WITH TRANSFER
COILERS
44'2½"
SHEET PACK TRANSFER
SECONDARY PLATE COOLING AREA
M.G. SET
#1 REVERSING MILL MOTOR ROOM
48" TANDEM MILL
#1 REVERSI
SKIN PASS MILL MOTOR ROOM
COIL STORAGE
ANNEALING FURN
SKIN PASS DEPT.
#2 MILL (2 STAND TANDEM)
#1 MILL (SINGLE STAND)
TRANSFER TRACK


FUME EXHAUST SYSTEM BLDG.
STORAGE RACK
CONVEYOR
ACID TANKS
M.G. SET
#2 REVERSING MILL MOTOR ROOM
#1 REVERSING MILL
#2 REVERSING MILL
ROLL GRINDER
ROLL GRINDER
CLEANER LINE #2
CLEANER LINE #1
CLEANER LINE #3
ANNEALING FURNACES
ANNEALING FURNACES
COIL ANNEALING DEPARTMENT
DX MACH
PURIFIER

Steam for the coke plant and strip mill is furnished by a boiler house at the coke plant. Six 600 hp. bent tube boilers, of 150 lb. pressure, burn coke breeze or coal on chain grate stokers. A load of 120,000 lb. per hr. is carried, and this system is connected back into the steel plant 200 lb. system. Feed water treatment for this house is entirely internal.

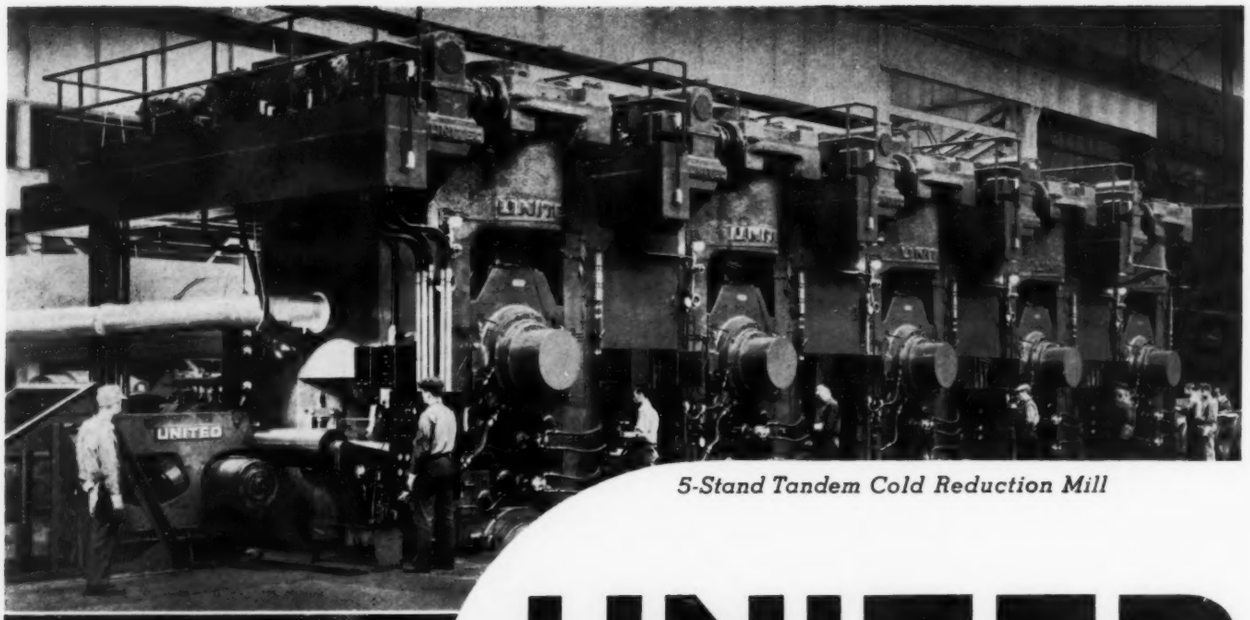
Service water is obtained from Lake Michigan through five intake screens, the main pump house consisting of two 15,000 gal. per min. and three 7700 gal. per min. motor driven pumps, which discharge into a 5 ft. 6 in. header. Two low-head booster pumps are also used in order to keep the intake full. In the power house, in addition to the various condenser pumps, are also four 7700 gal. per min. and a 4200 gal. per min. steam driven pumps, for general supply service. Another 4200 gal. per min. pump, electrically driven, operates to hold a constant level in the standpipe. A new 24 in. water line from the coke plant serves the strip mill, being mounted on an overhead bridge which also carries a 4 in. fuel oil line serving the strip mill.

Gaseous fuel is piped into the plant from a utility company. This gas may consist of straight oil refinery gas of 1450–2000 Btu. per cu. ft., or 1040 Btu. natural gas, or any mixture of the two. Specific gravity of the gas may vary from .6 to 1.2. A mixing station is provided wherein the gas is stabilized with air to a point where it is interchangeable with coke oven gas. Through a complete system of automatic controls, the mixture of refinery gas and air is controlled so as to maintain a flow factor equivalent to coke oven gas, so that the gas is interchangeable with coke oven gas without adjustment of furnace controls or burners. From the mixing station, a stabilized gas line extends to the strip mill and another to the steel plant. The strip mill usually operates on the stabilized gas only. At the steel mill, the coke oven gas header is connected in to the plant gas distribution system. Depending on coke plant operations and gas demands, the gas distributed in the steel plant varies from 10 to 90 per cent coke oven gas, mixed with the stabilized gas. For protection, the unstabilized gas is also brought in to the open hearth department, where it may be connected in to the general gas system if necessary.

Building	Lgth., ft.–in.	Width, ft.–in.	Cranes		
			No.	Capacity	Span, ft.–in.
Slab yard	625	94 – 2	2	25/10	90 – 0
Furnace building	125	60 – 4	–	–	–
Hot mill building	695	74 – 0	2	60/25	69 – 10
Hot mill motor room	545	60 – 4	1	35	56 – 4
Runout building	650	85 – 0	2	25/10	79 – 2
Hot finishing building	985	73 – 6.5	1	25/10	70 – 0
			2	15	70 – 0
Normalizing building	1100	35 – 0½	1	10	31 – 6
Coil storage building	504	93 – 6½	2	15	90 – 0
			1	10	90 – 0
Pickling building	650	65 – 0	1	10	61 – 4
Cold mill building	550	73 – 6½	1	50/10	70 – 0
			1	15/5	70 – 0
Skin pass mill building	265	60 – 2	1	50/10	56 – 4
Annealing and storage building	1010	73 – 8	1	15/5	70 – 0
Annealing and storage building	1010	36 – 8½	1	15	32 – 11
Annealing and storage building	770	73 – 8	2	15/5	70 – 0
Tin house	824	73 – 6½	1	5	70 – 0
Assorting building	824	83 – 6½	1	5	80 – 0
Warehouse	824	73 – 6½	2	5	70 – 0

STRIP MILL DATA

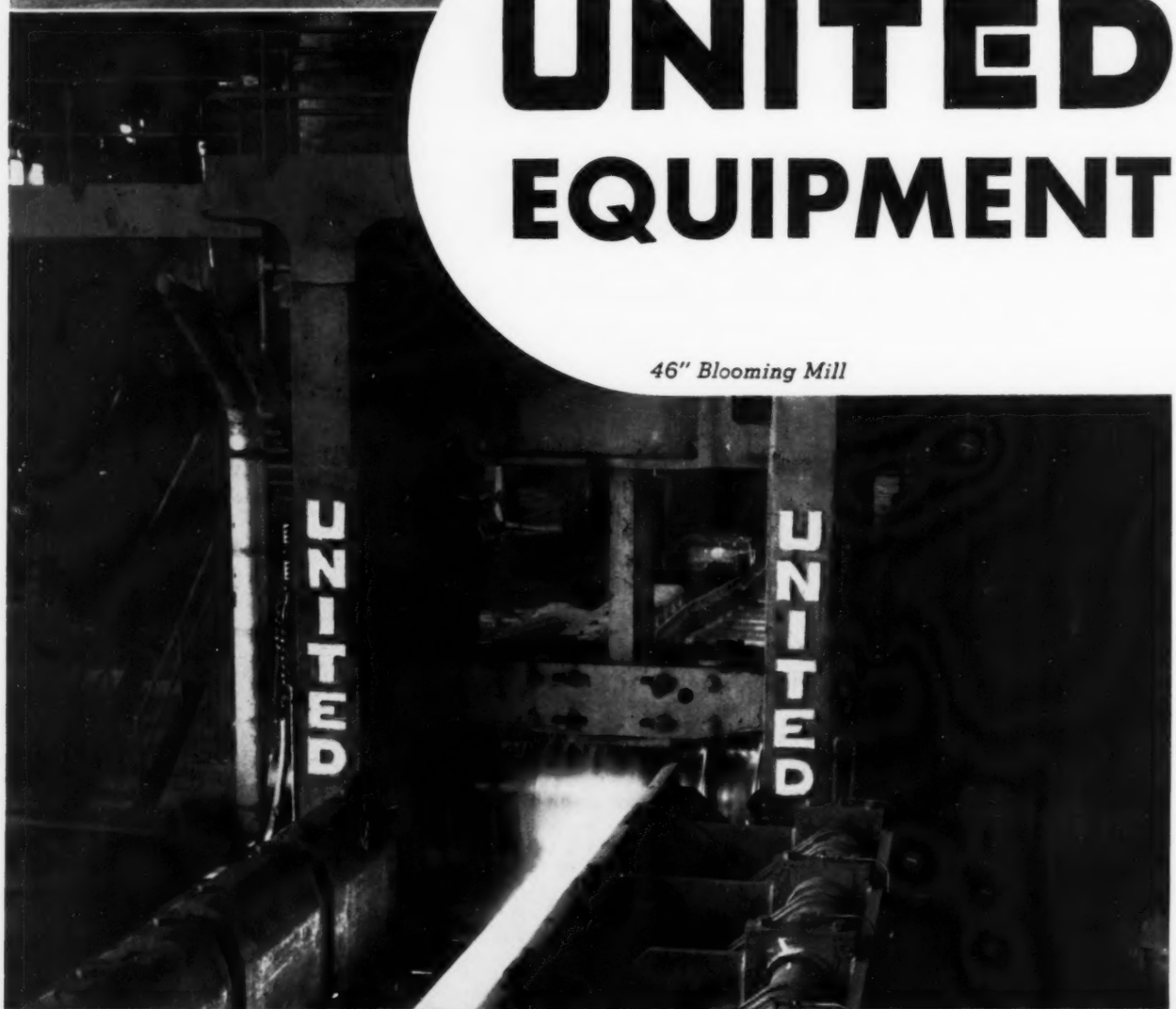
Stand	Characteristics	Roll length	Roll Diameter		Motor			
			Work rolls	Back-up rolls	Hp.	Volts	Rpm.	Type
Hot Mill								
No. 1 Scalebreaker	Vertical	8¼″	40″	–	(2) 300	2200	508	Induction
No. 1 Rougher	1 stand, 2 high	56″	40″	–	3000	2200	144	Synchronous
No. 2 Rougher	1 stand, 4 high	54″	24½″	45″	2500	2200	234	Induction
No. 3 Rougher	1 stand, 4 high	54″	22½″	45″	2500	2200	252	Induction
No. 4 Rougher	1 stand, 4 high	54″	22½	45″	2500	2200	252	Induction
No. 2 Scalebreaker	1 stand, 2 high	56″	25½″	–	500	600	150/600	d-c.
No. 5 Finisher	1 stand, 4 high	54″	22½″	45″	3000	600	200/400	d-c.
No. 6 Finisher	1 stand, 4 high	54″	22½″	45″	3000	600	200/400	d-c.
No. 7 Finisher	1 stand, 4 high	54″	22½″	45″	3000	600	200/400	d-c.
No. 8 Finisher	1 stand, 4 high	54″	22½″	45″	3000	600	200/400	d-c.
No. 9 Finisher	1 stand, 4 high	54″	22½″	45″	3000	600	200/400	d-c.
No. 10 Finisher	1 stand, 4 high	54″	22½″	45″	2000	600	230/460	d-c.
Cold Mills								
Tandem mill	1 stand, 4 high	48″	18″	49″	1500	600	300/600	d-c.
	1 stand, 4 high	48″	18″	49″	1750	600	300/600	d-c.
	1 stand, 4 high	48″	18″	49″	1750	600	300/600	d-c.
	1 stand, 4 high	48″	18″	49″	1750	600	300/600	d-c.
	1 stand, 4 high	48″	18″	49″	1750	600	175/437	d-c.
	Reel	–	20″	–	400	600	300/1200	d-c.
Reversing mill	1 stand, 4 high	42″	16½″	49″	2000	600	230/350	d-c.
	Reels (2)	–	30″	–	(2) 600	600	250/875	d-c.
Reversing mill	1 stand, 4 high	42″	16″	49″	1750	600	400/600	d-c.
	Reels (2)	–	30″	–	(2) 500	600	250/875	d-c.
Tandem skin pass mill	Entry reel	–	20″	–	(2) 25 kw.	125	90/360	d-c.
	Entry tension rolls	–	–	–	(1) 102 kw.	250	215/430	d-c.
	2 stands, 4 high	42″	18″	49″	(2) 350	230	215/430	d-c.
	Exit tension rolls	–	–	–	(1) 350	230	215/430	d-c.
	Reel	–	20″	–	(1) 150	230	95/380	d-c.
Skin pass mill	Entry reel	–	–	–	(2) 15 kw.	125		d-c.
	Entry tension rolls	–	–	–	(1) 102 kw.	230	575/1150	d-c.
	1 stand, 4 high	–	–	–	(1) 300	230	575/1150	d-c.
	Exit tension rolls	–	–	–	(1) 300	230	575/1150	d-c.
	Reel	–	20″	–	(1) 150	250	300/1200	d-c.
Temper mill	1 stand, 2 high	54″	28″	–	200	230	500/1000	d-c.
	Reel	–	–	–	200	230	300/900	d-c.
Temper mill	1 stand, 2 high	60″	28″	–	150	2200	1200	a-c.



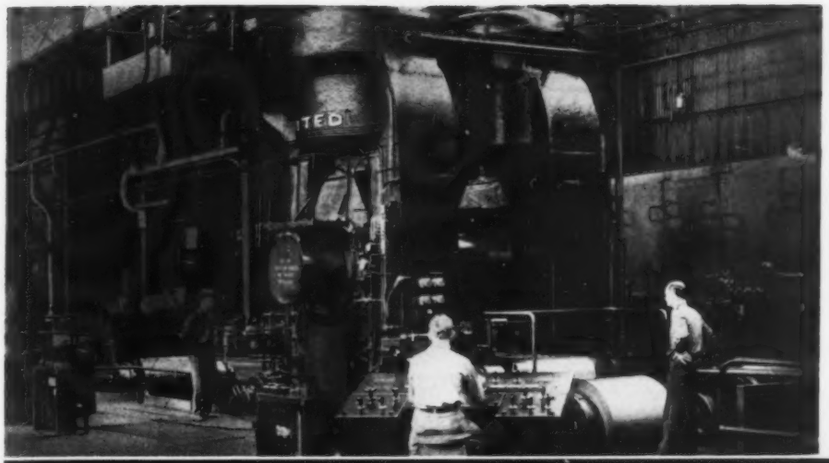
5-Stand Tandem Cold Reduction Mill

UNITED EQUIPMENT

46" Blooming Mill



UNITED ENGINEERING *and* FOUNDRY COMPANY
Pittsburgh · Pennsylvania



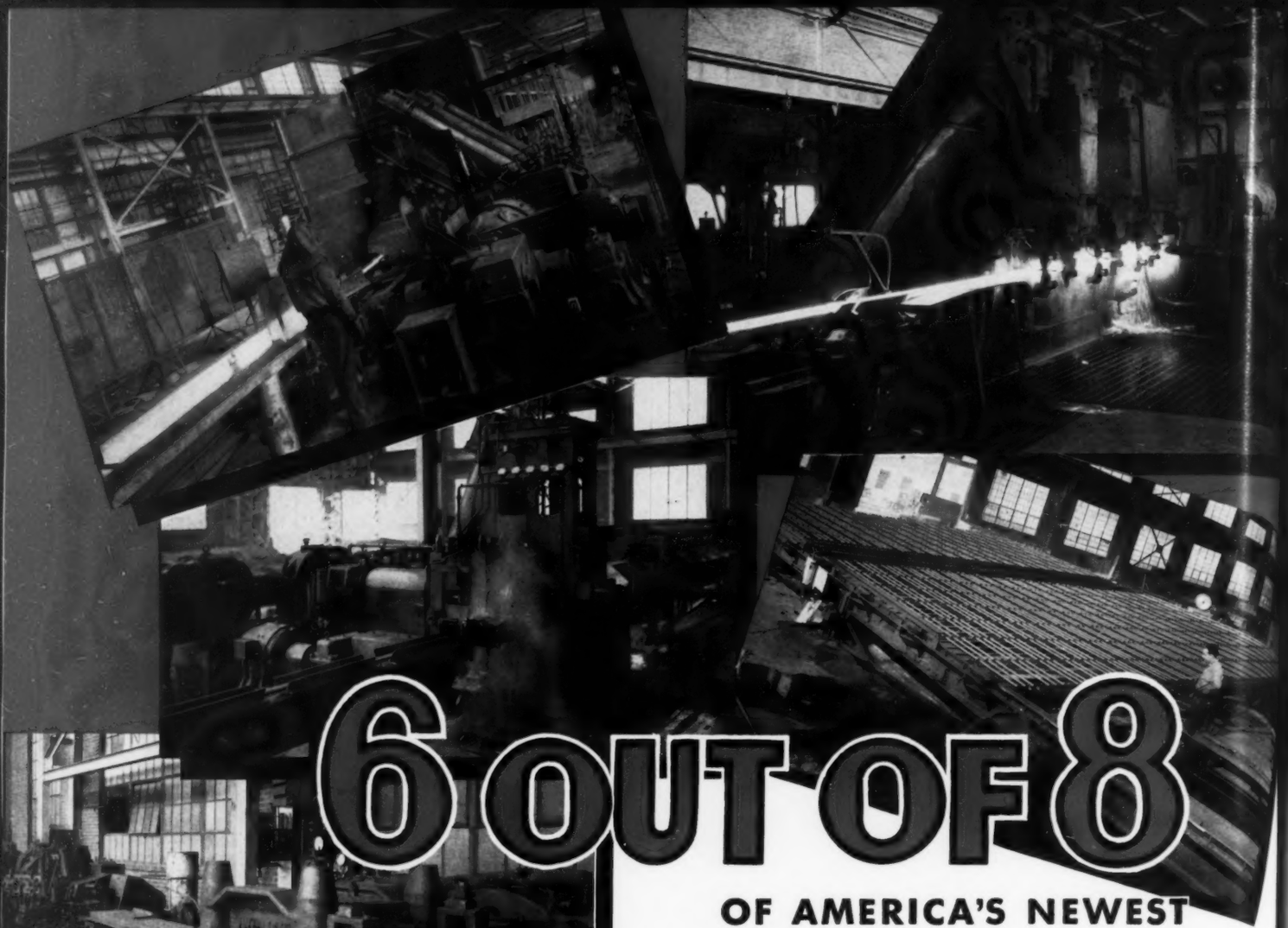
18" & 49" x 42"
4-High Reversing
Cold Mill

in YOUNGSTOWN SHEET AND TUBE COMPANY

Indiana Harbor Plant

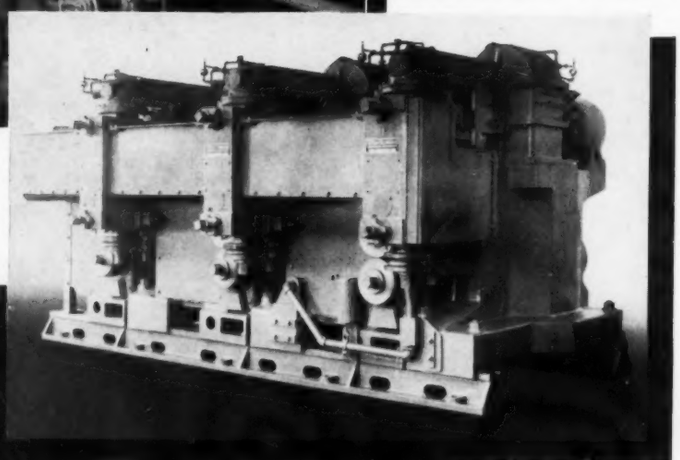
2-Stand Tandem Skin Pass Mill

DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND · DOMINION ENGINEERING WORKS, LTD., MONTREAL, P. Q. · UNITED INTERNATIONAL, S. A. PARIS, FRANCE · SHIBAURA-UNITED ENGINEERING CO., TOKYO, JAPAN



6 OUT OF 8

OF AMERICA'S NEWEST CONTINUOUS BUTT WELD PIPE MILLS ARE AETNA EQUIPPED • •



● Since 1939 when the most modern type of Continuous Butt Weld Pipe Mills were first installed, this Country's largest producers of pipe have shown an outstanding preference for AETNA-STANDARD machinery.

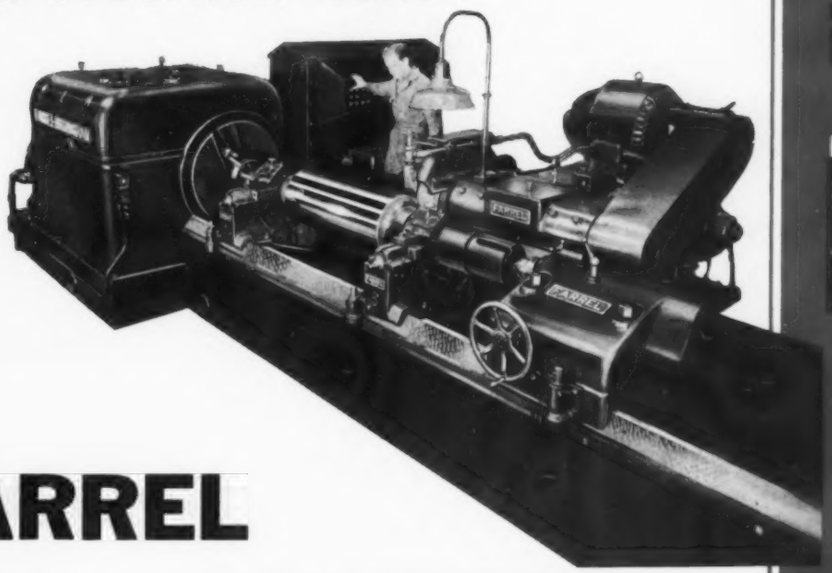
Aetna-Standard Engineers, with international experience and attainment as their credentials, are always available for the study of your particular problems.

The AETNA-STANDARD ENGINEERING COMPANY
Youngstown, Ohio

CONSULTANTS • DESIGNERS and BUILDERS TO THE STEEL AND NON-FERROUS INDUSTRIES

Associated Companies: HEAD, WRIGHTSON & CO. LIMITED, THORNABY-ON-TEES, ENGLAND • AKTIEBOLAGET ARBOGA MEKANISKA VERKSTAD, ARBOGA, SWEDEN • AETNA-STANDARD ENGINEERING COMPANY, LTD., TORONTO, ONTARIO, CANADA

For Fast Production of High Precision Rolls



FARREL ROLL GRINDERS

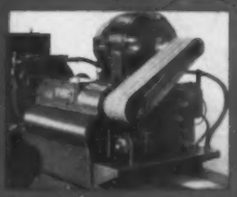
The Farrel Heavy Duty Roll Grinder is both a production and a precision machine. It operates continuously at maximum speed . . . gives high output . . . grinds rolls of any material with extreme accuracy. It grinds perfect surfaces free from all marks . . . grinds straight, concave or convex contours of exact symmetry . . . applies the finest mirror finish or does heavy roughing equally well.

Automatic and semi-automatic features so minimize dependence on the operator's skill that there is no necessity for frequent stops to make adjustments or correct defects. With this machine is secured close control of accuracy and finish to meet predetermined standards.

Full information at Booth 224, Iron and Steel Show

The construction and operation of Farrel Heavy Duty Roll Grinders will be explained in detail during the Iron and Steel Show by Farrel engineers stationed at Booth No. 224. They will also be glad to give you full information on Farrel Gears and Gear Units, Gearflex Couplings and the entire line of Farrel-Birmingham machinery.

Illustrated below are some of the features which contribute to the low-cost, high-output, high-accuracy performance of Farrel Heavy Duty Roll Grinders.



Heavy, Rigid, Smooth-Running Spindle.

Automatic, Accurate, Symmetrical Roll Crowning and Concaving.

Centralized, Finger-Tip Control.

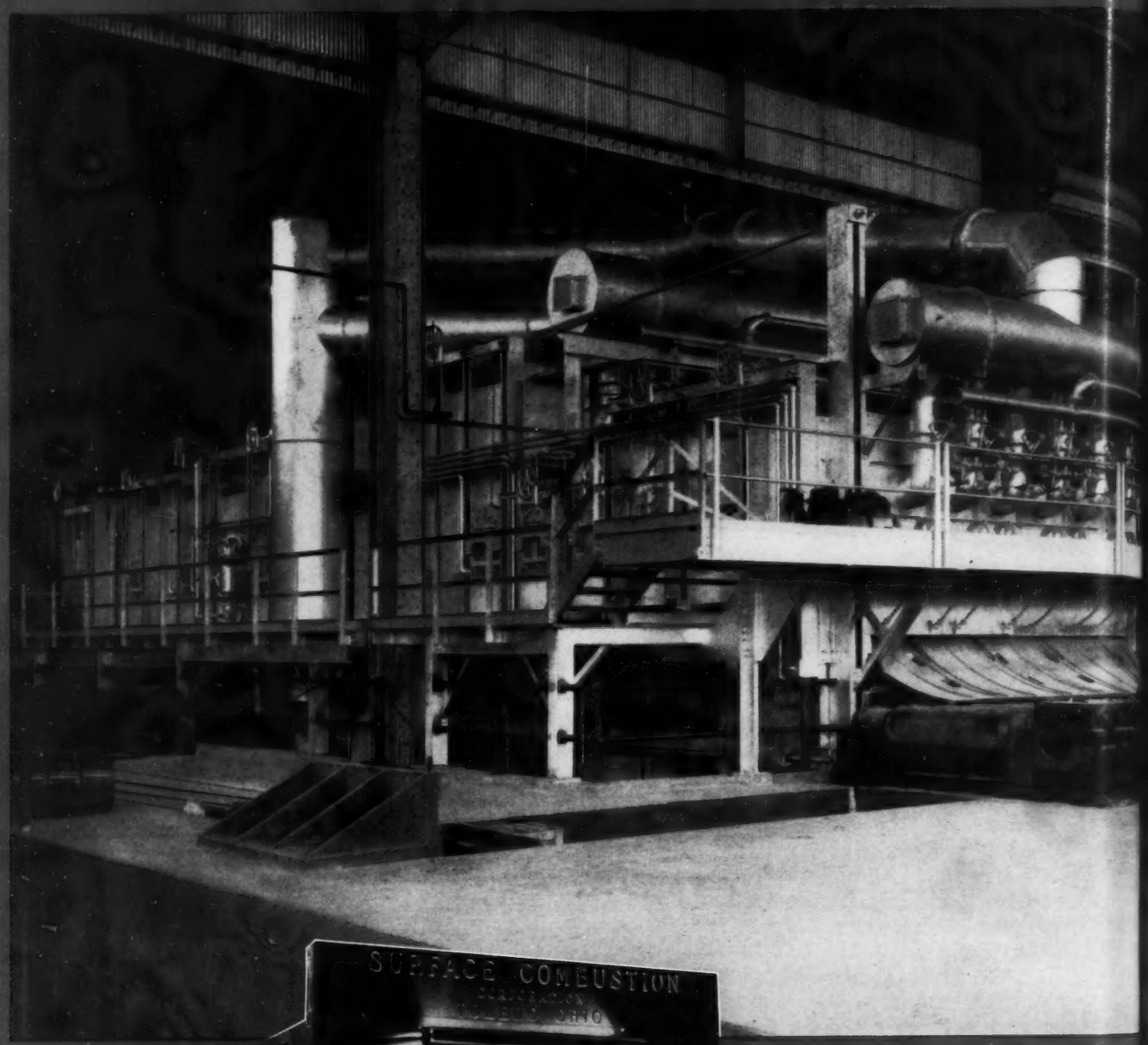
Compact, Self-Contained, Smooth-Running, V-Belt Roll Drive.

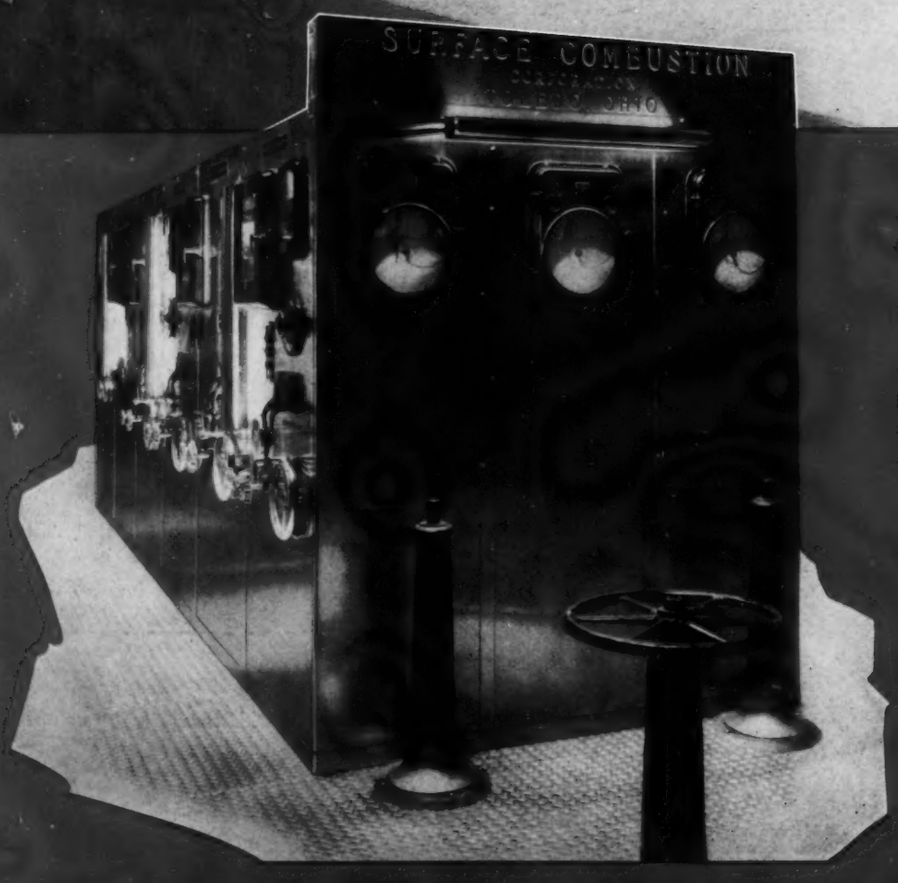
VISIT FARREL BOOTH No. 224 IRON & STEEL EXPOSITION CHICAGO Sept. 24-27, 1940

FARREL

FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.

New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles





● *The control panel is located between the two furnaces and contains all necessary instruments for complete automatic control of furnace temperature, atmosphere, and pressure. The automatic proportioning controls for fuel and air are provided with manual-automatic control valves. Each zone is equipped with hand operated valves as well as motor operated valves.*

TWO HUGE SC SLAB HEATERS SERVE YOUNGSTOWN'S NEW 54-INCH STRIP MILL

● *Completely automatic temperature and combustion control is provided in all zones—the top and bottom fired preheat zone, the top and bottom fired heating zone, and the soaking zone.*

DESIGNED to feed as much as 160 gross tons of slabs per hour to the new 54" strip mill at the Indiana Harbor Plant of The Youngstown Sheet and Tube Company are two Surface Combustion Slab Heating Furnaces. Both in dimensions and capacity, these furnaces are believed to be the largest in existence.

Each furnace has a normal rated capacity of 60 gross tons per hour and an overload capacity of 80 gross tons per hour. To obtain the overload capacity, special burners, firing above and below the steel, are provided in a preheat zone located in the channel of the furnaces.

Either coke oven gas or oil can be used as the fuel. Air for combustion is preheated in carborundum recuperators located beneath the furnaces.

SURFACE COMBUSTION CORPORATION...Toledo, Ohio

SURFACE SC COMBUSTION

Builders of... ONE WAY FIRED SOAKING PITS, BILLET HEATERS, PACK OR PAIR, ANNEALING, CONTROLLED ATMOSPHERE FURNACES, NORMALIZERS

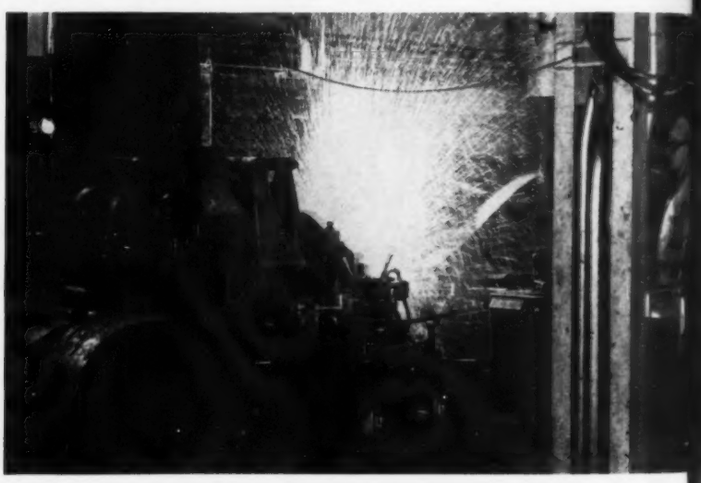
Again THE CONTINUOUS WAY THAT IS *More*

UNTOUCHED by hand from a coil of skelp to finished tubes on the cooling rack, tubing produced by the Fretz-Moon Process brings further evidence that motor-drive can be more than power. Skelp is moved at an overall speed best suited for a given tube size. Its travel during and between operations is automatically timed to suit what is happening at other points in the process. Such effective team-work by machines and motors comes from preparatory team-work by mill men, equipment builders and motor engineers. The next time you talk about such things, ask a Reliance Engineer to sit in. He will have something worthwhile to contribute, not alone because of varied past experience but because he is one of a group in which the power and control end of processing material in coil form is a matter of daily study.

▲ ▲ ▲ ▲

Photos by courtesy of The Youngstown Sheet and Tube Company

Coiled skelp first enters roller leveller driven by 40/50 hp. d-c. adjustable-speed Type T Motor.



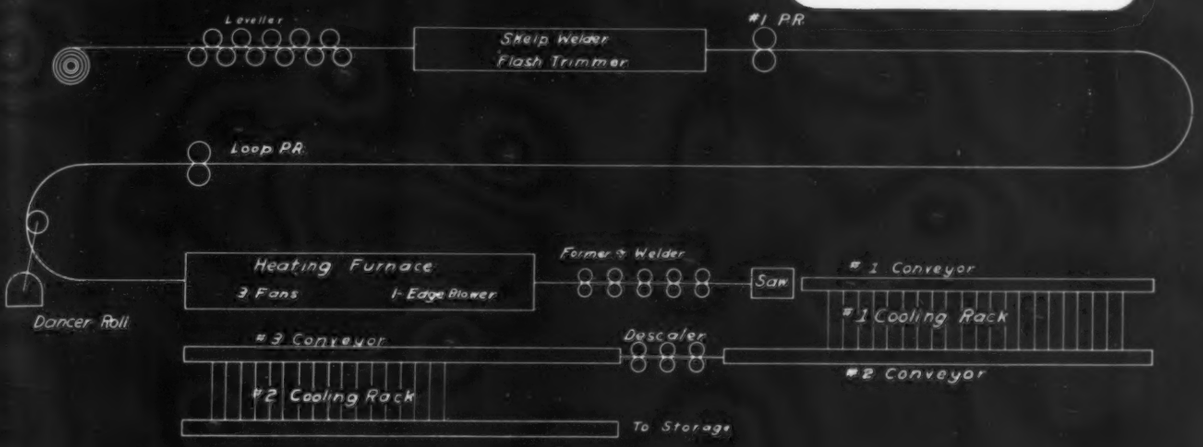
Leaving the leveller, the nose of the new coil is butt welded electrically to the trailing end of preceding coil. A 5/7½ hp. d-c. adjustable-speed motor provides power for the welder "push-up."

Skelp entering heating furnace. Magnetic rollers (not used in all cases) are driven by 3/5 hp. d-c. adjustable-speed motor.

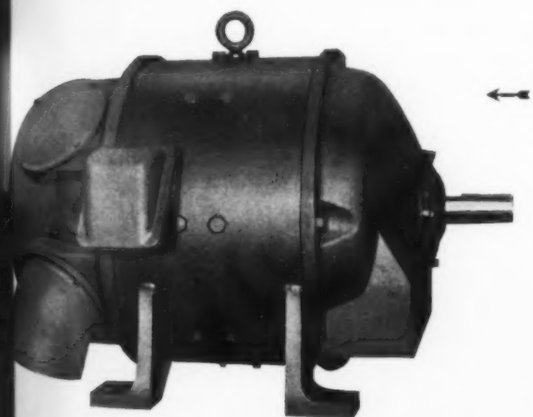
Here the heated skelp is being formed and rolled. Power for this operation is provided by a 40/50 hp. d-c. adjustable-speed Reliance Motor.

DEPENDS UPON MOTOR-DRIVE *than Power!*

9 Mills in U.S.A. using Fretz-Moon Process are equipped with Reliance Motor-drive.



Typical layout for butt-weld tube mill using the Fretz-Moon Process. As many as 20 d-c. adjustable-speed motors and 8 a-c. motors may be used. A five-unit motor-generator set supplies variable voltage. . . . In addition to the production range of 66 to 400 f.p.m. (the speed depending upon diameter of tube) it is necessary to have slower speeds for starting a new run. This wide range is provided by a combination of field control (4:1) and voltage control. . . . To avoid undue tension or buckling of the hot skelp it is essential to maintain a close speed relationship between the loop pinch roll and the former and welding machine. This is accomplished by means of the dancer roll actuated by the skelp and serving to maintain the loop.



Splash-proof Type T D-c. Reliance Motor as used for adjustable-speed drives on leveller, descaler former and welder. Vital parts are protected against scale and moisture. . . . These motors are designed for a speed range of 4 to 1 by field control. This combined with variable-voltage control provides for slow speeds when starting a new lot of tubing and a production range of 66 to 400 f.p.m. depending upon the size of the tube.

Splash-proof Squirrel-cage Reliance Motor. Used for furnace fans and edge blowers. The windings are protected against heavy flying scale.

ANCE ELECTRIC & ENGINEERING CO.
VANHOE ROAD CLEVELAND, OHIO

gham, Boston, Buffalo, Chicago, Cincinnati, Detroit, ille (S. C.), Houston, Los Angeles, New York, Phila-, Pittsburgh, Portland (Ore.), St. Louis, San Francisco, Syracuse (N. Y.), and other principal cities.

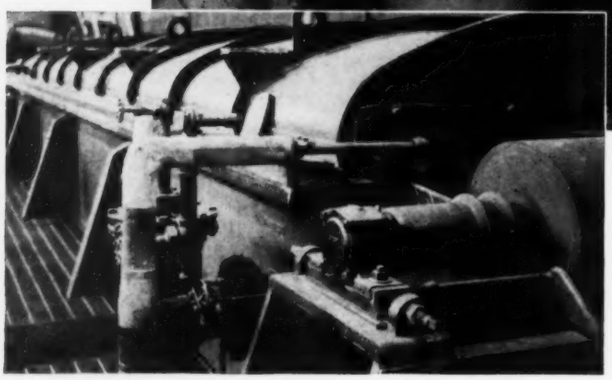
RELIANCE A-C D-C MOTORS

MOTOR DRIVE IS MORE THAN POWER

SKF's are working

AT THE INDIANA HARBOR WORKS

of Youngstown Sheet & Tube Co.



SKF
Bearings

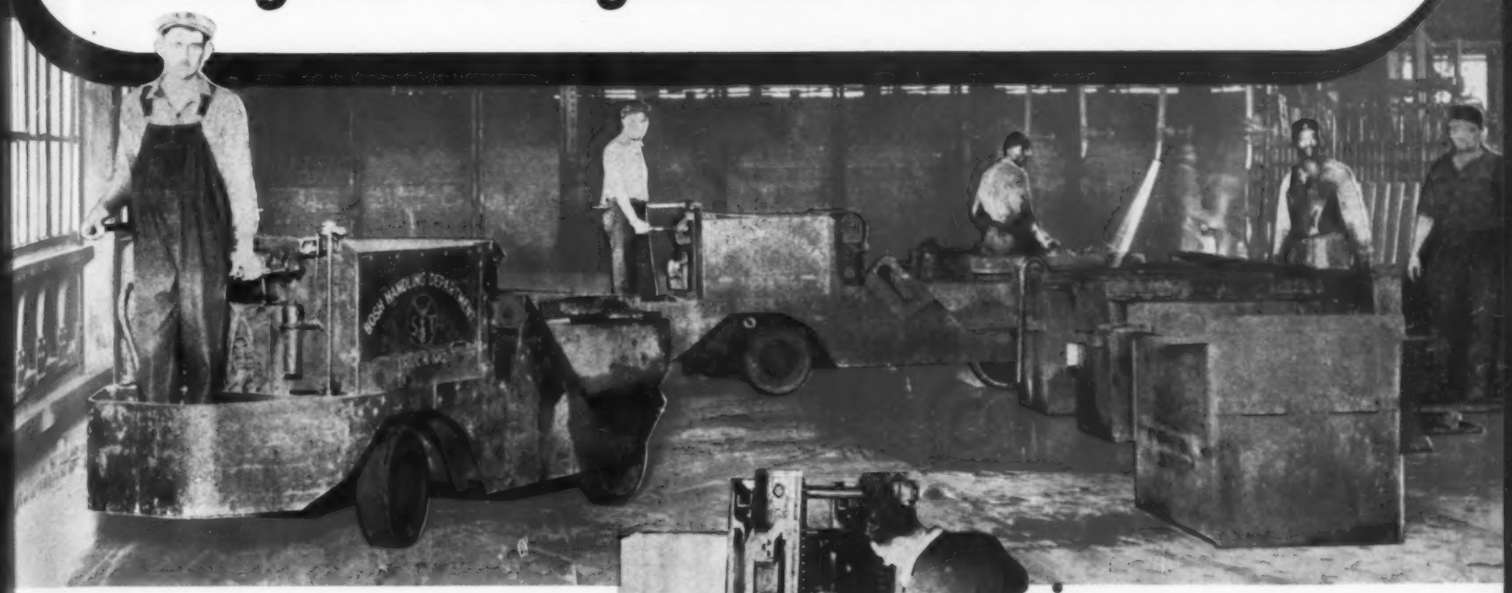
In the Indiana Harbor Works, you will find SKF Spherical Roller Bearings doing a variety of jobs from end to end of the mill and from top to bottom . . . from Roll Grinders to Hot Strip Coilers built by Mesta Machine Company . . . Strip Scrubber Line built by Youngstown Foundry & Machine Company . . .Cranes built by Morgan Engineering Company . . . Motors built by Westinghouse Electric & Manufacturing Company.

You will find SKF Bearings on *modern* steel mill equipment WHEREVER YOU GO because their quality and practical design enable them to do the job *right.* They are self-contained, and their rolling alignment compensates for warpage, deflection and misalignment. Their high capacity is always 100% available. They need no adjustments, either in assembly or for wear. By using SKF Bearings, you, too, can put the *right* bearings in the *right* places.

4646

SKF INDUSTRIES, INC., PHILADELPHIA, PA.

BAKER TRUCKS *keep tin plate moving for Youngstown Sheet and Tube*



ABOVE Baker Bosh Handling Tractors save time and money at Youngstown Sheet and Tube's tin mill.

RIGHT A fleet of Baker Fork Trucks efficiently handles tin plate in sorting and shipping rooms. Smooth, fast, easy operation cuts handling costs.

At the Indiana Harbor Mill of Youngstown Sheet and Tube, Baker Trucks and Tractors are providing efficient, dependable material handling.

● Modern production methods call for faster, more efficient handling of materials and equipment. One of the many large mills using Baker Trucks for this important plant function is the Indiana Harbor Mill of The Youngstown Sheet and Tube Company.

These Baker units have solved many difficult handling problems. If you want to handle tin plate, coils, sheets, etc., at lowest cost, let us show you what Baker Trucks can do for you.

BAKER INDUSTRIAL TRUCK DIVISION
of the Baker-Raulang Company
2166 WEST 25TH STREET • CLEVELAND, OHIO

IN CANADA: Railway & Power Engineering Corporation, Ltd.

Trade mark Registered U. S. Pat. Off.
Baker INDUSTRIAL TRUCKS

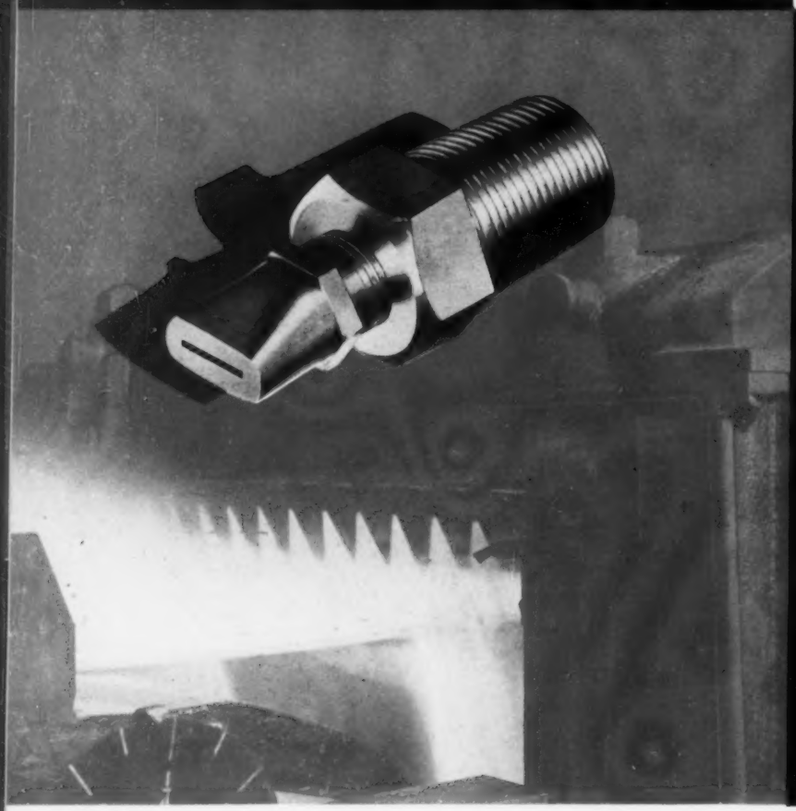
VISIT THE BAKER EXHIBIT AT THE IRON AND STEEL EXPOSITION, BOOTHS 74, 75, 76.

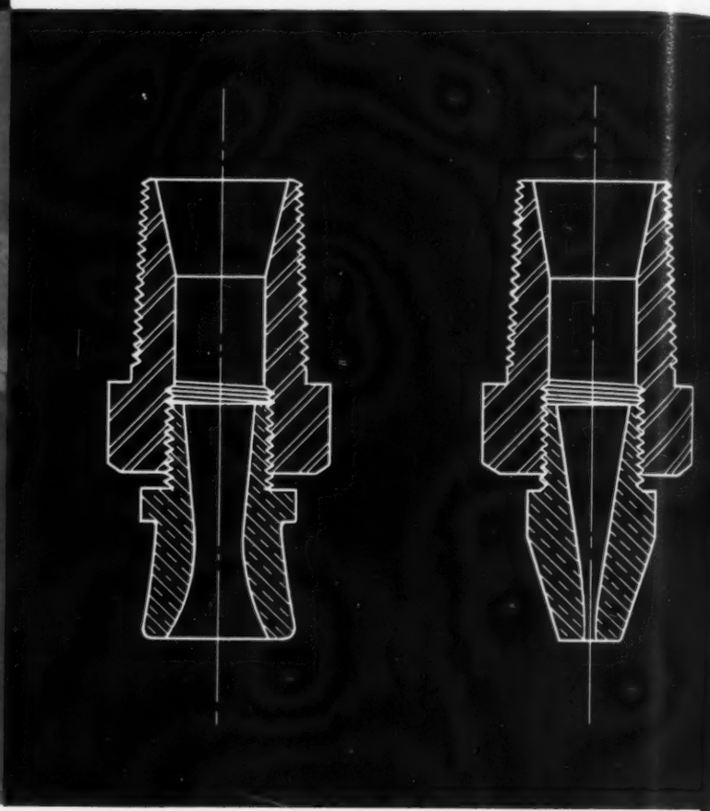
TRABON

CLEANER STEEL

CAN BE ROLLED BY THE USE OF

TRABON *Spray Nozzles*





See these new TRABON Spray Nozzles at the Iron and Steel Exposition — BOOTH 200

TRABON Spray Nozzles consist of only two parts—the header adapter made of stainless steel, and the nozzle which fits into it, the latter forged from a solid Monel bar.

After years of development the TRABON *Spray Nozzle* for descaling steel is now made available to the entire steel industry. For several years past it has been in service in various plants of one of the largest steel producers, proving its value in day-in-and-day out service. . . . So efficiently has the TRABON *Spray Nozzle* served that its use is a definite part in the program of producing cleaner steel and a better finished steel.

From Bloom to finished Product TRABON *Spray Nozzles* in the pressure headers of the descaling system guarantee the most efficient manner of providing clean steel for the finishing operations. Nozzles with finer openings are available for cooling operations.

If your mill is already using a water spray descaling system, install a TRABON *Spray Nozzle* where you can check its performance most easily—and its performance will tell you all you want to know about its efficiency. Or order the quantity required to equip one header and watch results.

See our other advertisement on W-27 featuring the new

TRABON HYDRAULICALLY OPERATED BARREL PUMPS

TRABON ENGINEERING CORPORATION

1814 E. 40TH ST. CLEVELAND, O.

THE *Material Handling* *is* **MODERN,** *too!*

This battery industrial truck is capable of handling 25,000 lb. coils, picking them up and setting them down exactly where wanted.

Its batteries are exchanged as needed by this electric hoist.

When you visit the Indiana Harbor Works of the Youngstown Sheet and Tube Company be sure to see the modern, efficient methods of material handling employed.

All the principal mechanical handling systems are in use, including a large, well-maintained fleet of self-loading battery industrial trucks. These trucks serve for the movement of all types of material in process at exactly the rate required by the cold mills, cleaners, shears and other machines, thus contributing to efficient production.

Among them are some of the largest ram trucks in service, capable of handling 25,000-lb. coils and powered by steel-alkaline batteries having a rated capacity of 48.6 kilowatt-hours.

To anyone interested in modern material-handling methods, a visit to this modern plant is sure to prove worth while.

EDISON **STORAGE BATTERY**

DIVISION OF THOMAS A. EDISON, INC. WEST ORANGE, NEW JERSEY, U.S.A.

We favor adequate preparedness for national defense and recommend enlistment in the U. S. Army to eligible young men.

PYLETS

Built for Heavy-duty Mill Service

These improved conduit fittings offer many practical advantages in design and construction that contribute to safe, strong, weatherproof installations, and simpler application in all types of heavy duty wiring jobs. Among the many features of Pylets are—self-aligning covers, dowel pin type Everdur corrosion resisting screws, warped covers for tight and uniform gasket seal, smooth interior with rounded edges to prevent chafing of wires, large wiring space, reinforced hubs, accurate, taper threads, malleable iron bodies with double weatherproof finish.

Investigate the many features of Pylets that contribute to ease of application, security, and economy. Bulletins with complete listings of all types will be sent upon request.

SPACE 202
Iron & Steel Exposition
Chicago

Let us show you Pyle-National electrical equipment on the tough jobs in the Chicago district.

PYLE-NATIONAL

The Pyle-National Company, *General Offices and Works,* 1334-58 North Kostner Avenue, Chicago, Illinois • *Offices:* New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco.

CONDUIT FITTINGS • LOCOMOTIVE ELECTRICAL EQUIPMENT • FLOODLIGHT PROJECTORS

AN INTRICATE SYSTEM

PIPE OF HIGH CARBON CONTENT

...yet installed with full satisfaction the AIRCO way

Miles of pipe varying in diameter from ¼ to 24 inches — numerous elbows, ells, bends, manifolds — all help make the new Indiana Harbor Plant of Youngstown Sheet and Tube Co. one of America's finest and most up-to-date hot and cold strip mills. Welding the largest size — a pipe higher than average in carbon content—presented a real problem. On the recommendation of our Applied Engineering Department the superior Airco Multi-Layer Technique and Airco No. 1 Alloy Rod were tried. Tests were conducted and welds proved 100% in all bend and tensile tests. Welding then proceeded this Airco way — Result: a leakproof, compact, highly satisfactory piping system.

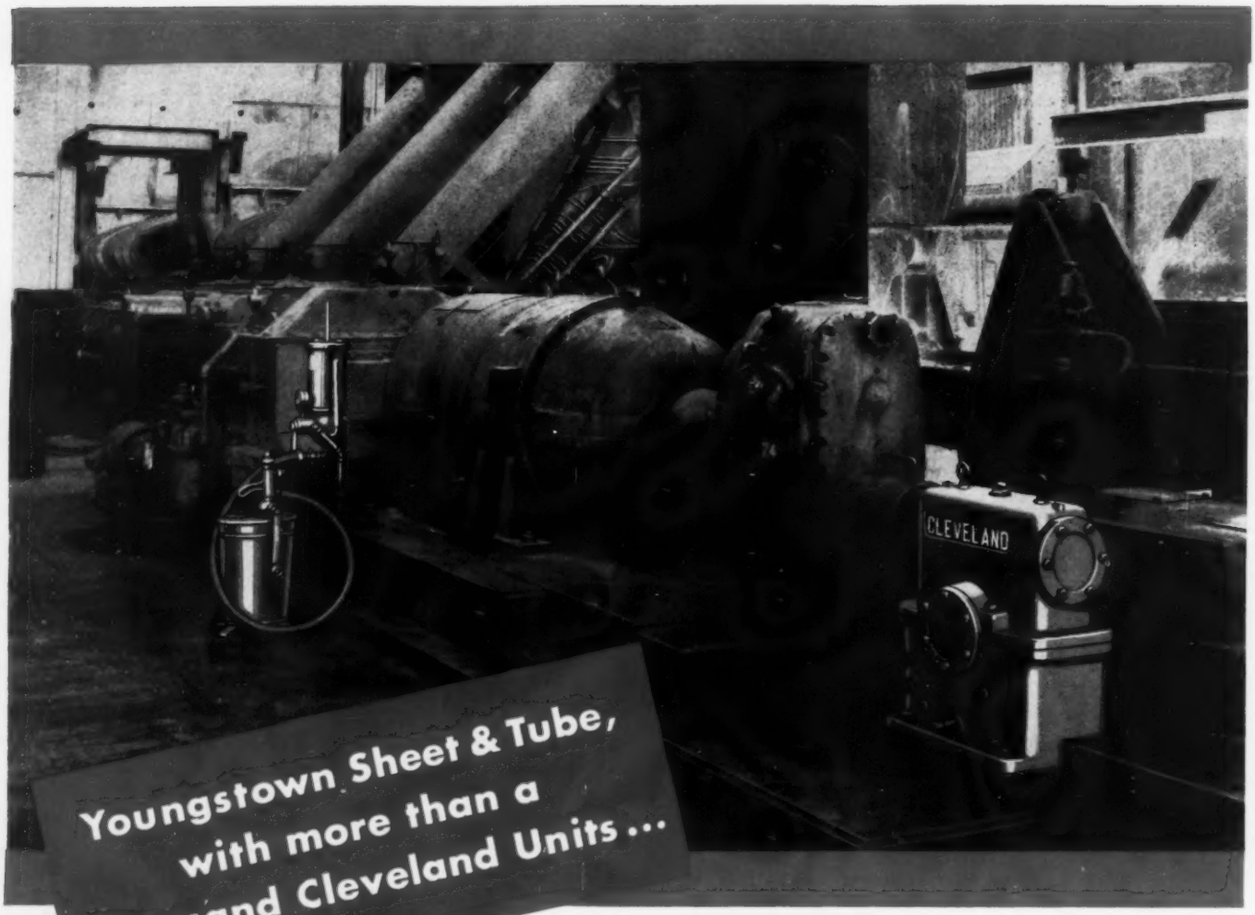
When in doubt, consult Airco on all problems involving the use of the oxyacetylene flame. We will gladly help you find the most workable solution. Write for full details.

AIR REDUCTION

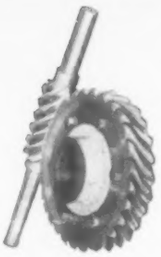
General Offices: 60 EAST 42nd STREET, NEW YORK, N. Y.

DISTRICT OFFICES IN PRINCIPAL CITIES

AIRCO *Anything and Everything for* GAS WELDING or CUTTING and ARC WELDING WILSON



Youngstown Sheet & Tube, with more than a Thousand Cleveland Units...



...again installs Cleveland Drives in its new Continuous Butt Weld Pipe Mill

Youngstown took a look at Clevelands' 20-year record in their several plants—and again selected them for this *new* project.

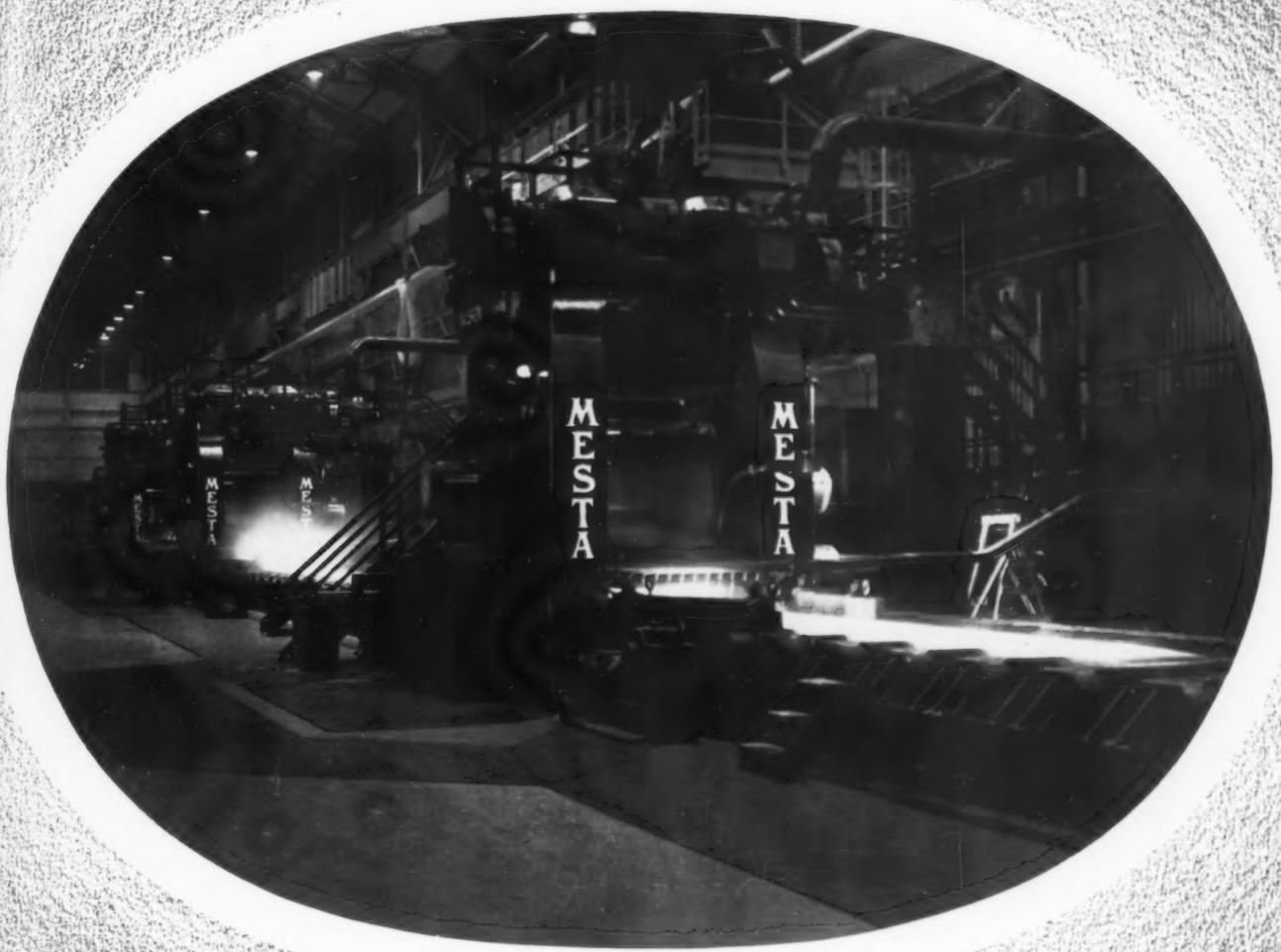
Thus, Cleveland Worm Gear Drives are installed in Youngstown's new Continuous Butt Weld Pipe Mill, including the Forming and Welding Mill and Automatic Hot Saw illustrated above.

No other industry subjects power drives to the relentless punishment they receive in Steel, where dependable operation is paramount. Yet more Cleveland Worms and Gears have been bought for steel production than for any other major industry.

You can rely on Clevelands to operate dependably throughout the lifetime of your mill equipment—without need for parts replacement and with little or no expense for maintenance. The Cleveland Worm & Gear Company, 3278 E. 80th St., Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication
In Canada: PEACOCK BROTHERS LIMITED

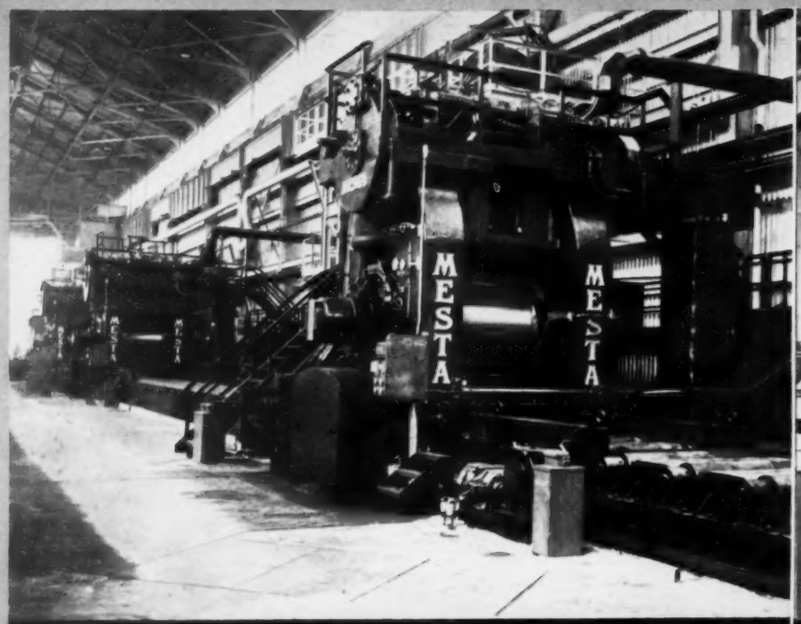
CLEVELAND WORM GEAR *Speed Reducers*



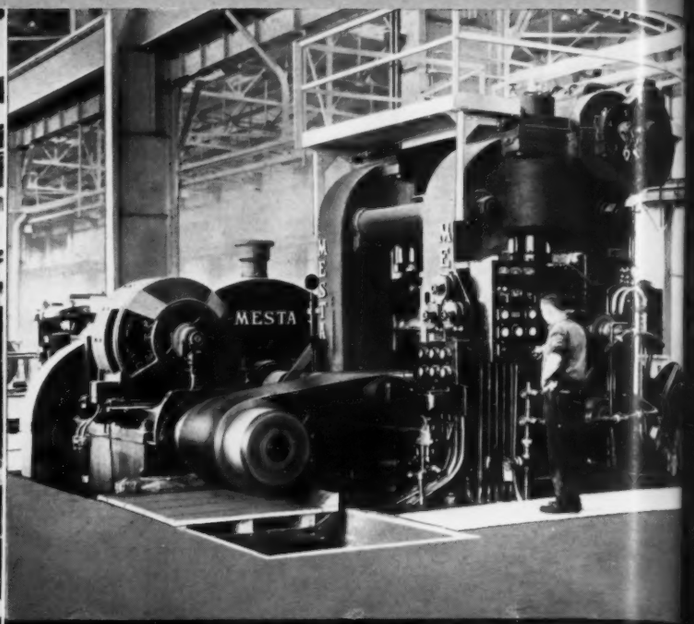
54" Four-High Ten Stand Continuous Hot Strip Mill at
Indiana Harbor Works, Youngstown Sheet and Tube Co.

MESTA EQUIPMENT INSTALLED IN THE MILLS OF YOUNGSTOWN SHEET AND TUBE COMPANY

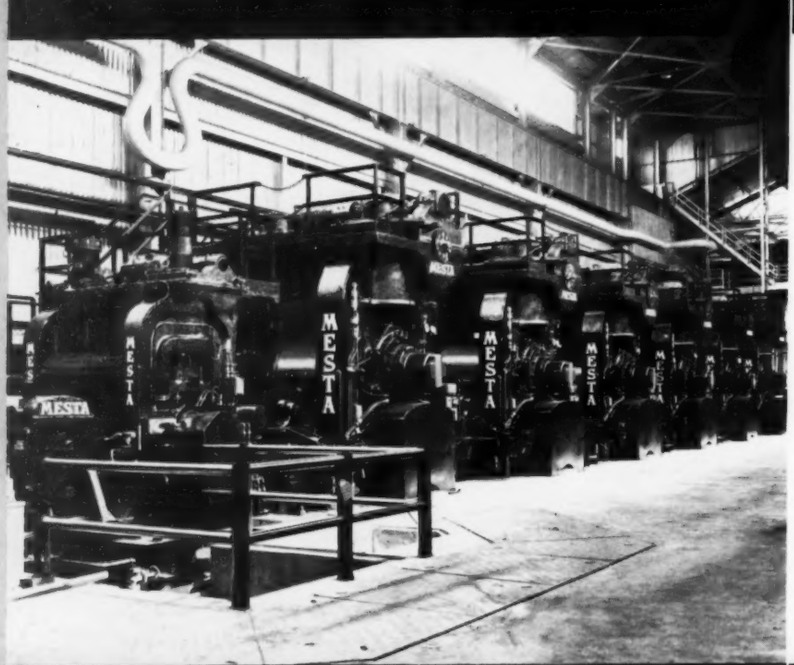
★ ★ ★



Roughing Stands, 54" Four-High Continuous Hot Strip Mill

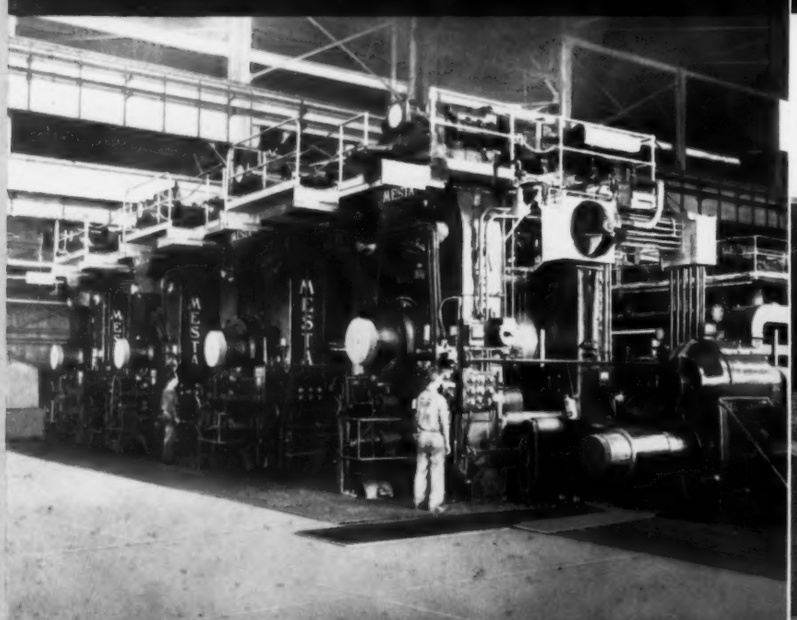


55" Two-High Skin Pass Mill for Strip

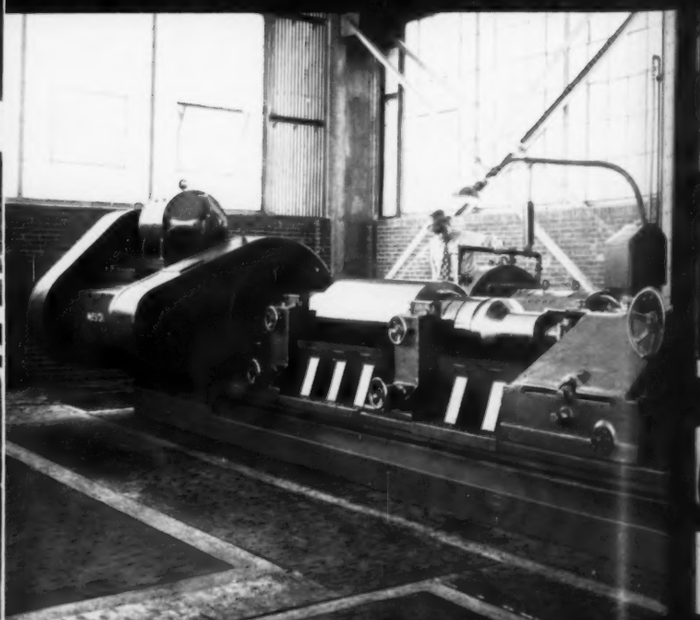


Finishing Stands, 54" Four-High Continuous Hot Strip Mill

MESTA—
and builders o
steel mill e



54" Four-High Tandem Cold Mill for Thin Sheet Gauges



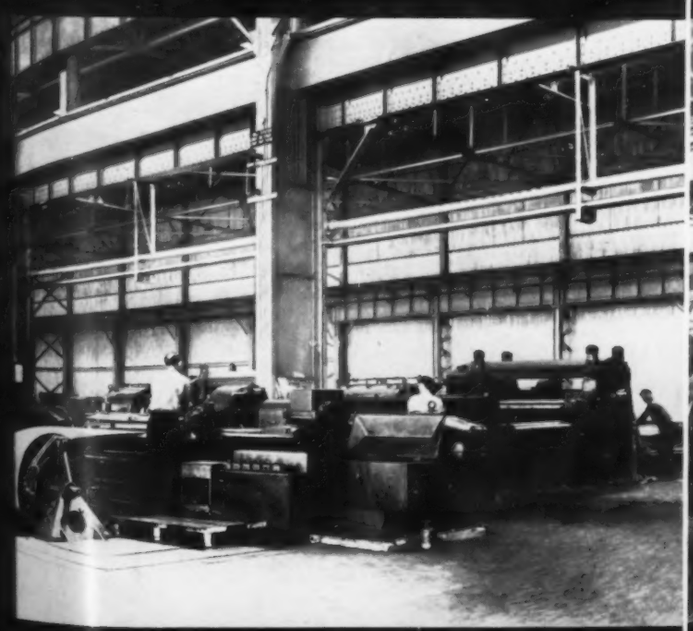
Mesta Heavy Duty Roll Grinder

75" Four-High Single Stand Mill, with Mesta Patented Sheet Charger for Skin Passing Sheets

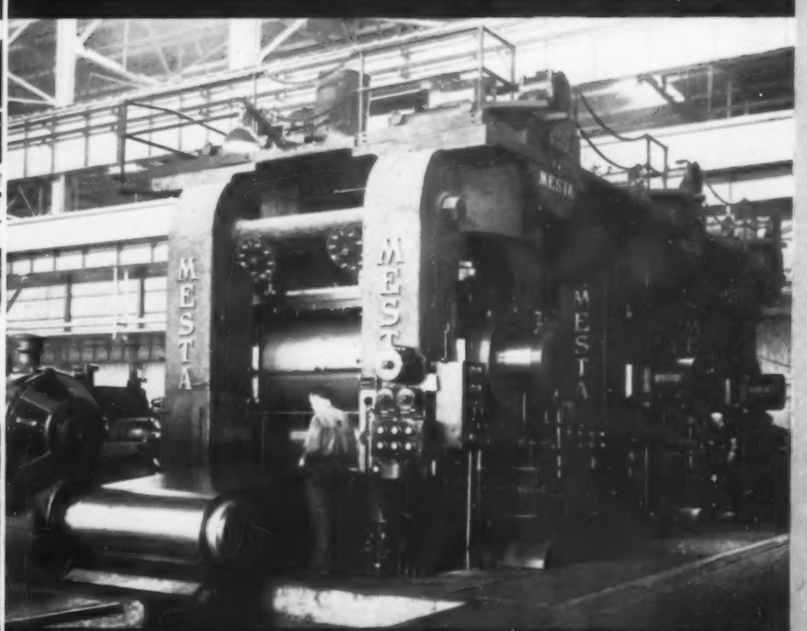
Roughing Stands, 79" Four-High Continuous Hot Strip Mill

TA—designers ers of complete ill equipment

Finishing Stands, 79" Four-High Continuous Hot Strip Mill



Mesta Trimming, Levelling and Shearing Line



75" Four-High Three Stand Tandem Cold Mill for Rolling Sheet Strip

MESTA PRODUCTS

are built in the largest unit plant in the world devoted to the production of ROLLS and STEEL MILL EQUIPMENT

COMPLETE ROLLING MILL EQUIPMENT

Bar Mills
Billet Mills
Blooming Mills
Continuous Mills
Merchant Mills
Non-Ferrous Mills
Piercing Mills
Pipe Mills
Plate Mills
Rail Mills
Rod Mills
Sheet Mills
Shovel Mills
Skelp Mills
Slabbing Mills
Four-High Hot Strip Mills
Four-High Cold Strip Mills
Structural Mills
Tin Plate Mills
Tire Mills
Tube Mills
Universal Mills
Wheel Mills

Mesta Patented Flying Shears
Bar Shears
Billet Shears
Bloom Shears
Crop Shears
Hydraulic Shears
Lever Shears
Plate Shears
Slab Shears
Squaring Shears
Steam Hydraulic Shears
Furnace Charging Equipment
Manipulators
Mill Tables
Flexible Couplings
Shear Gauges
Slab Scales
Cooling Beds
Transfers
Conveyors
Pushers
Buggies and Cars
Hot Saws

Cold Saws
Pack Annealing Beds
Annealing Boxes
Gear Drives
Cut and Machine Molded Iron and Steel Gears
Coilers
Coil Boxes
Pilers
Mesta Patented Feed Reels
Tension Reels
Belt Wrappers
Mesta Patented Sheet Chargers
Electrolytic Cleaning Lines
Mesta Patented Pickling Machines
Continuous Pickling Lines
Processors
Flash Welders
Trimmers and Slitters
Stitching Machines
Straightening Machines
Levellers
Scrap Ballers

ROLLS AND MILL PINIONS

Steel and Alloy Steel Rolls
Mesta Grain Rolls
Chilled and Sand Iron Rolls
"Mesta Special" Alloy Steel Rolls
Mesta Hardened Chill Rolls
Mesta Hardened Grain Rolls
Heat Treated Special Alloy Steel Rolls
Backing-Up Rolls
Forged Hardened Steel Rolls
Cut Tooth Mill Pinions
Machine Molded Mill Pinions

FORGINGS

Open Hearth and Electric Furnace Alloy and Carbon Steel

Large Shafts, Ship Shafts, Billets, Blooms, Piston Rods, Connecting Rods, Locomotive Axles, Reaction Towers, Air Bottles, Boiler Drums, Crankshafts and General Forgings

PRESSES AND EQUIPMENT

Hydraulic and Steam Hydraulic Forging, Bending, and Forming Presses — Large Power Presses
Intensifiers — Accumulators

SPECIAL MACHINE TOOLS

Heavy Duty Table-type Planers
Heavy Duty Post-type Planers
Heavy Duty Pit-type Planers
Heavy Duty Draw-Cut Shapers
Heavy Duty Boring Mills
Gear Planing Machines
Combination Shaping, Boring and Milling Machines
Heavy Duty Boring and Turning Lathes
Trepanning Lathes — Ingot Slicers
Roll Grinders — Roll Lathes
Gear Hobbing Machines

GAS AND STEAM ENGINES FOR BLAST FURNACES, ROLLING MILLS AND POWER PLANTS

Una-Flow Engines (Stumpf Patents)
Piston and Corliss Valve Engines
Reversing Engines
Blowing Engines
Barometric Condensers
Air Heads
Air Compressors
Vacuum Pumps
Mesta Automatic Plate Valves (Iversen Patents)

CASTINGS

Acid Open Hearth, Carbon and Alloy Steel Castings and Forging Ingots, Air Furnace Iron Castings, Bronze Castings

MESTA MACHINE COMPANY, PITTSBURGH, PA.

In still another famous steel mill... the Indiana Harbor Plant of Youngstown Sheet and Tube... you find...

KEMP at WORK

Check off all the tin stacks you know of that were recently built or recently modernized... they've ALL got one thing in common . . . Kemp Immersion Melting (with gas).

Here are four reasons, terse enough to write on your cuff, interesting enough, we hope, for you to write for details:

1. Faster production—no crew can outstep hot metal
2. Improved quality through closest temperature control ever secured
3. Fuel saving, records show 40 percent — Heat is applied *inside* the metal
4. Dross sharply reduced, now more important than ever

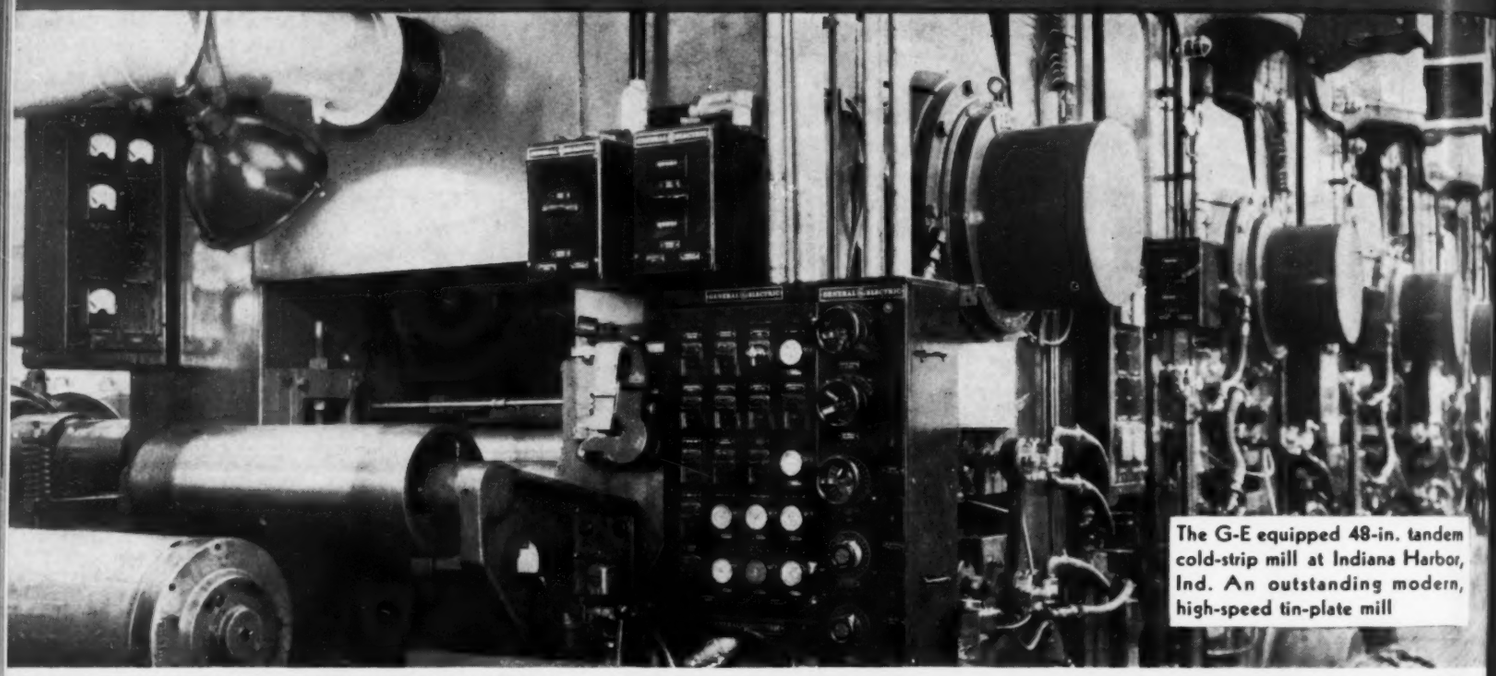
For that additional, detailed information, we spoke of, address **The C. M. Kemp Mfg. Co., 405 E. Oliver St., Balto. Md.**

Close-up of tin pot at Indiana Harbor showing feed and exhaust elements of Kemp Immersion heating units.

KEMP of BALTIMORE

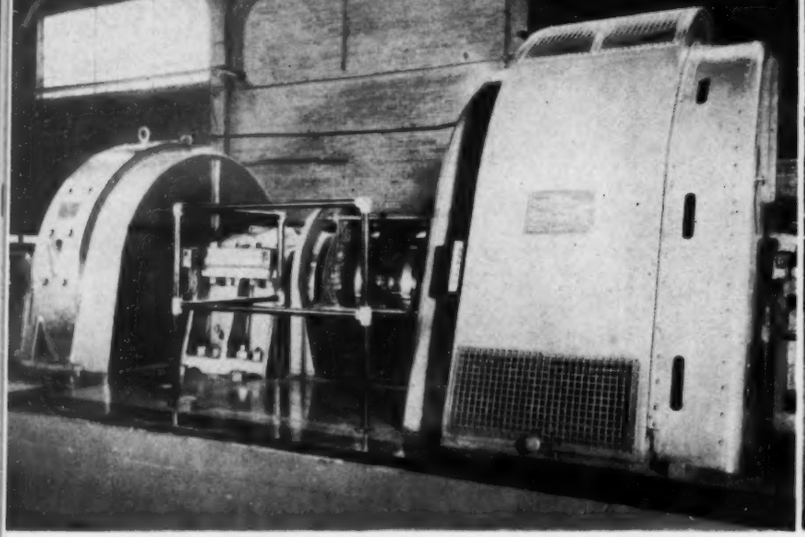
STEEL'S HIGHEST-POWERED

ROLLS TIN PLATE

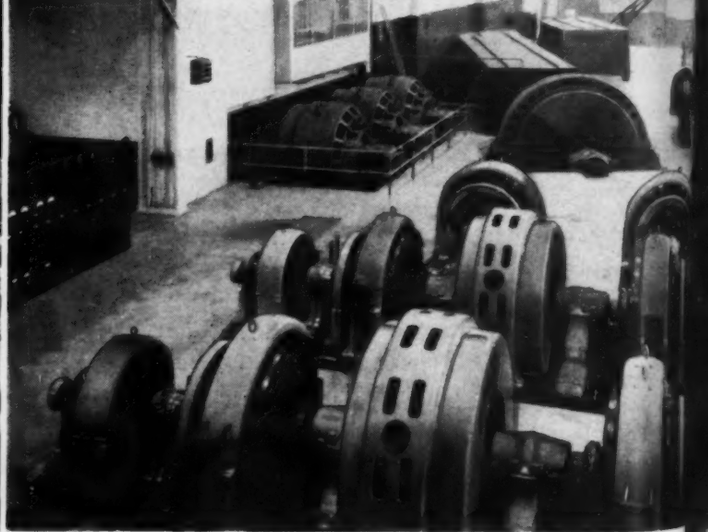


The G-E equipped 48-in. tandem cold-strip mill at Indiana Harbor, Ind. An outstanding modern, high-speed tin-plate mill

EQUIPMENT AT YOUNGSTOWN THAT SHOWS G-E



THE SECOND LARGEST ADJUSTABLE-SPEED A-C MOTOR (6000 hp). Drives stands 8, 9, and 10 in 24-18-inch billet mill. It is part of a constant-horsepower Kraemer drive, which also includes a 6200/4920-hp induction motor and a 0/1150-hp d-c motor. Installed in 1929.



WORLD'S LARGEST ADJUSTABLE-SPEED A-C MOTOR (7500 hp). In motor room of the 21-in. continuous sheet bar and skelp mill (center background of picture). It is part of a constant-torque Kraemer drive, which includes the other G-E equipment shown. System was installed in 1926.

G E N E R A L

COLD-STRIP MILL . . .

THE LOW-COST WAY

G-E Precision Control Slashes Scrap Losses, Maintains Quality, in High-tonnage Production at Youngstown

EIGHTY-NINE hundred horsepower in main drives, a delivery speed of 2100 fpm! But the new 48-inch five-stand tandem cold-strip mill of the Youngstown Sheet and Tube Company has *even more* than power and speed!

It has a control system in which have been incorporated practically all of the electrical refinements found on the latest and best tin-plate mills. This system helps the mill to do a *real* job of rolling tin plate—to roll high tonnages of smooth-finish, on-gage strip, with an amazingly small amount of scrap. It includes:

TAPERED-TENSION CONTROL, which increases the tension between the stands when the mill is started up and tapers it off as the mill approaches normal running speed, reversing the action in the slowing-down process. This brings the strip on gage much faster and keeps it on longer than would otherwise be possible.

INDICATING TENSIOMETERS between the stands, which enable the operator to see what the tension is at all times. He can, as a result, keep it within safe limits and thus prevent strip wrinkling or breakage.

AMPLIDYNE GENERATORS—these are high-speed exciters specially designed to function as control units. They maintain such electrical and mechanical values as voltage, speed, and tension with amazing dependability.

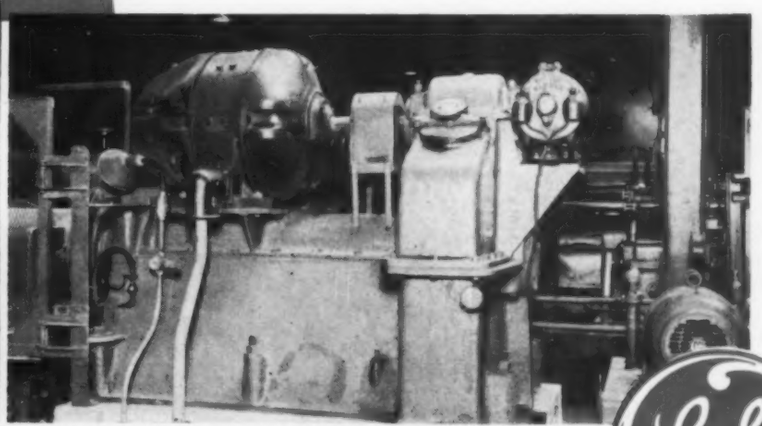
AUTOMATIC GAGE CONTROL, which provides a means of compensating automatically for any variations in gage that may occur when the mill is up to speed.

These and numerous other features have been expertly co-ordinated into a precise, responsive, smooth-working system that has won the praise of steel men.

This mill is completely G-E equipped, with motors, motor-generator set, and control applied and co-ordinated by G-E engineers. It's another example of how General Electric contributes to increased tonnages, improved quality, and lower costs in steel production. General Electric, Schenectady, N. Y.

ENGINEERING LEADERSHIP

D-C DRIVE FOR RUNOUT TABLES. G-E direct-current motors in the 54-in. hot-strip mill. The steel industry continues to recognize the advantage of direct-current motors with Ward Leonard control for runout tables and coilers in wide-hot-strip mills. This is another G-E contribution to better, more economical steel-mill operation.



MOTORS FOR PROCESSING LINES. These standard motors are giving dependable, low-maintenance service on cleaning line No. 2 in the tin-plate mills at Indiana Harbor. In center is a Type CD, 40/60-hp, d-c motor. At right is a totally enclosed, fan-cooled induction motor. Motors like these show how General Electric can meet all drive requirements.

GENERAL ELECTRIC

HERE ARE THE TIMKEN BEARINGS AT YOUNGSTOWN SHEET AND TUBE CO. INDIANA HARBOR WORKS

2-Hi Cold Planishing Mill. Roll necks are mounted on TIMKEN bearings. The big advantage of using TIMKEN Bearings in this type mill is that they permit mill stopping and starting under load to check gauge and finish without loss of material.

18" and 49" x 48" 4-Hi Tandem Cold Mill

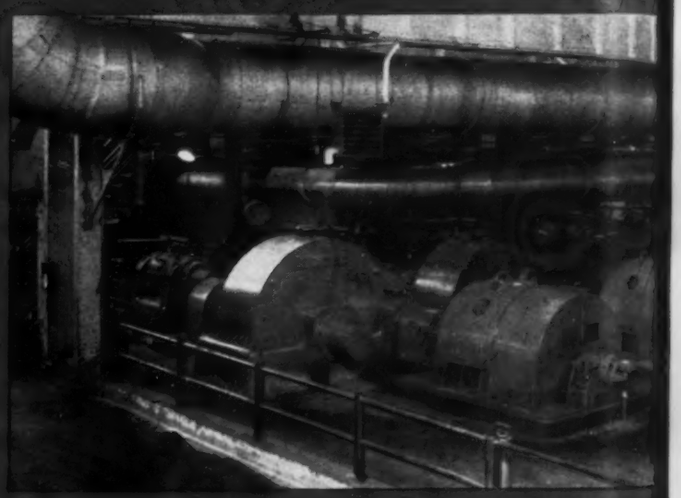
TIMKEN Bearings are used on the work rolls of all five stands as well as in the pinion stands, screwdowns and gear drives.

46" Roughing Mill

TIMKEN Bearings are used in all bearing positions in the screwdown.

16½" and 49" x 42" 4-Hi Cold Reversing Mill

TIMKEN Bearings are used on work rolls, in gear drive, screwdown, pinion stand and tension reel drive.



Drive end of 18" and 49"x48" 4-Hi Tandem Cold Mill. TIMKEN Bearings used on work rolls, pinion stand, screwdown and gear drive.

18" and 49" x 42" 4-Hi Tandem Cold Mill

TIMKEN Bearings are used on work rolls of all four stands and in all the screwdowns and pinion stands.

18" and 49" x 42" 4-Hi Skin Pass Mill

Work rolls, combination gear drive and pinion stand, screwdown and roll drive.

28" x 54" 2-Hi Planishing Mill

All roll necks and screwdowns.

22½" x 45" x 54" 4-Hi Hot Strip Mill

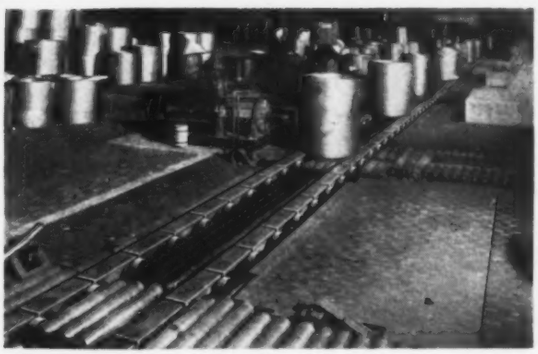
TIMKEN Bearings used on work rolls of all nine stands and in combination gear drives and pinion stands.

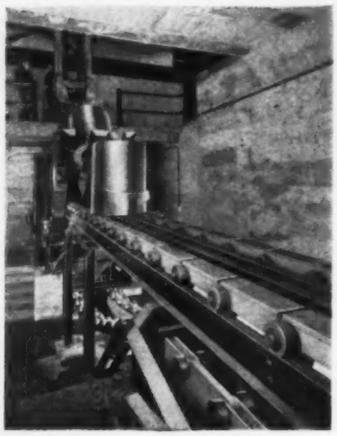
46" Blooming Mill. TIMKEN Bearings used in all anti-friction bearing positions.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN
TAPERED ROLLER BEARINGS

How Coils Are Handled on *LINK-BELT CONVEYORS* AT YOUNGSTOWN'S NEW 54″ STRIP MILL





ABOVE: Top illustration shows two lines of conveyors handling hot coils from two down-coilers. The coils are transferred to the storage conveyor shown in the foreground and in the view directly above. While traveling on this conveyor they are automatically weighed and cooled.

•

LEFT: 48″ cold coils are handled on tunnel conveyor from storage to elevator for delivery to finishing floor.

•

RIGHT: 48″ cold coils are handled from storage and lowered on up-ender to tunnel conveyor for delivery to elevator and down-tilter.

● At Youngstown Sheet & Tube Co.'s new Indiana Harbor, Ind., 54″ strip mill, Link-Belt conveyors, totalling 778-ft. long, handle coils of hot strip steel weighing from 7,000 to 12,000 lbs. each, from one vertical and two down coilers to storage. Enroute on the conveyors, the coils are automatically weighed and cooled.

Another Link Belt conveyor, 153-ft. long, transfers 48″ cold coils from storage to the finishing floor.

● All of these conveyors consist of Link-Belt 12″ and 18″ pitch, double strand, steel-bar-link anti-friction rolling chain. The driving mediums used are Link-Belt herringbone and worm gear speed reducers. All shafts are equipped with Link-Belt Shafer anti-friction roller bearing pillow blocks. The down-tilters and up-enders are also of Link-Belt design.

Let a Link-Belt steel mill specialist recommend the best equipment for your purpose.

LINK-BELT COMPANY ● Chicago, Indianapolis, Philadelphia, Atlanta, Dallas, San Francisco, Toronto, Pittsburgh, Cleveland, Detroit. Other offices warehouses, distributors in principal cities.

LINK-BELT CONVEYORS

See our EXHIBIT at the IRON & STEEL EXPOSITION, Booth 93, Stevens Hotel, Chicago, Sept. 24-27.

REINFORCED BUS SUPPORTS

are your

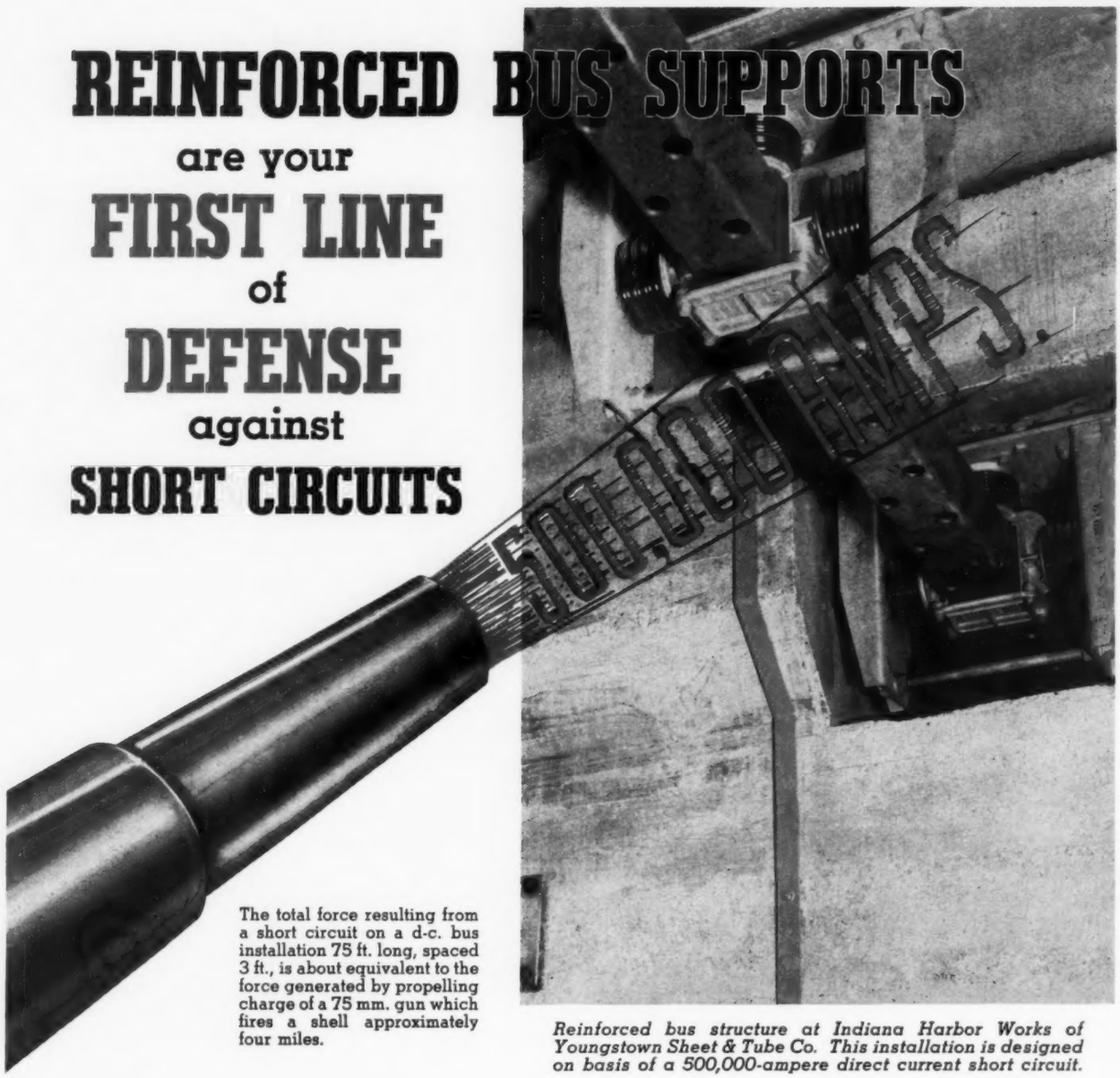
FIRST LINE

of

DEFENSE

against

SHORT CIRCUITS



The total force resulting from a short circuit on a d-c. bus installation 75 ft. long, spaced 3 ft., is about equivalent to the force generated by propelling charge of a 75 mm. gun which fires a shell approximately four miles.

Reinforced bus structure at Indiana Harbor Works of Youngstown Sheet & Tube Co. This installation is designed on basis of a 500,000-ampere direct current short circuit.

LIKE FIRING A GUN, a short circuit literally shoots energy into the bus structure. Enormous forces are developed almost instantaneously. Unless bus-bars and bus supports are strong enough to withstand the impact, disaster results.

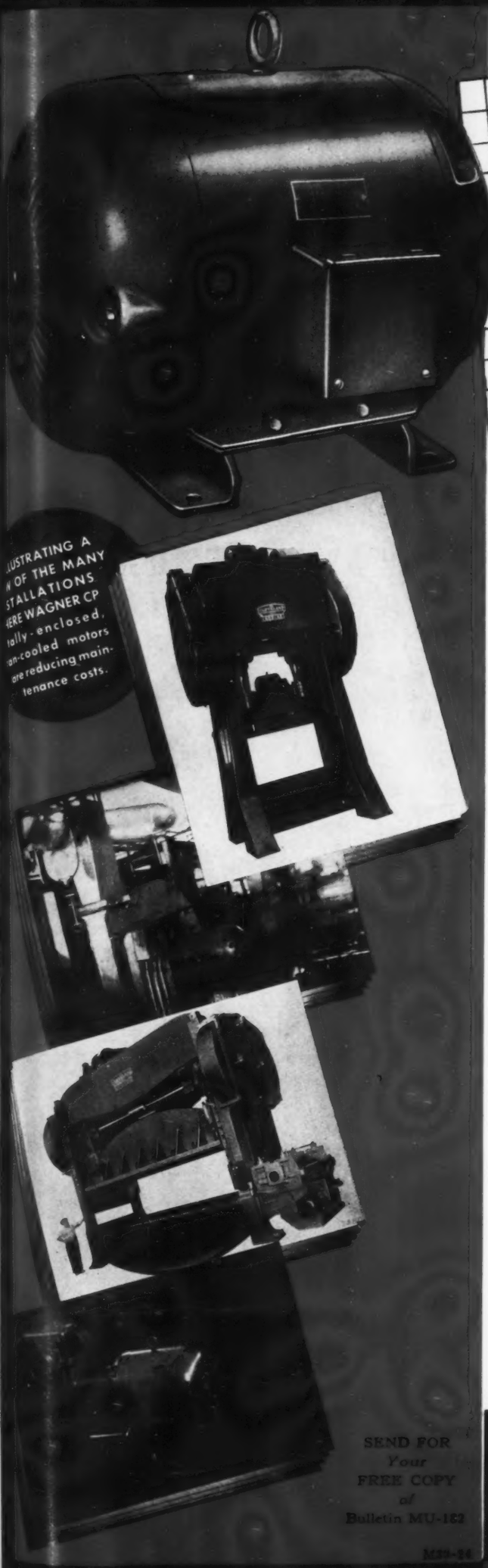
DELTA-STAR designed reinforced bus structures are your first line of defense against destructive short-circuit stresses. They provide security at least expense.

May we help you on your next installation. A letter will bring an experienced engineer to your office to discuss your problem and to plan with you a construction meeting your requirements.

DELTA-STAR ELECTRIC CO.

2400 Block, Fulton St. Chicago, Illinois

Built for the Future *Based on the Past*



MAINTENANCE COSTS *Go Down When* WAGNER MOTORS *Are Put on the Job—*

The high efficiency and dependability of Wagner, totally-enclosed fan-cooled motors make them the choice in the iron and steel industries.

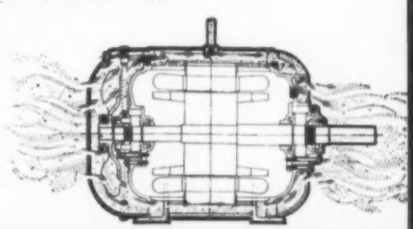
Thousands of them now in service attest to their ability to reduce maintenance costs by giving longer service under the most severe conditions.

Here are some of the reasons why they give longer service:

1. Rugged, welded all-steel stator with specially impregnated windings.
2. Dynamically-balanced rotor, equipped with sturdy shaft having all key-ways end milled.
3. Full-cartridge-bearing construction which completely seals and protects the ball bearings.
4. Easily accessible grease plugs permitting lubrication without removing fan shield or stopping motor.
5. End plates heavily and ruggedly constructed, with air deflector on shaft end.
6. Single-end ventilation with non-clogging, one-piece aluminum fan of split hub construction.
7. Fan shield formed from sheet steel and easily removable for access to fan.
8. Nine leads connectable for either 220 or 440 volts completely sealed in outlet, making it impossible for abrasive materials to enter motor

The Two-Frame Construction Keeps Dust, Dirt and Metal Chips from Entering the Vital Parts of the Motor—

Examine the cross-section drawing of the Wagner CP totally-enclosed fan-cooled motor illustrated at right. There are two frames—an outer frame that guides a strong cooling draft over the motor, and an inner frame with clearances around the shaft only, through which nothing obstructive or injurious can enter the vital parts of the motor.



Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

MOTORS • TRANSFORMERS • FANS • BRAKES

Specify

WAGNER HYDRAULIC BRIDGE BRAKES

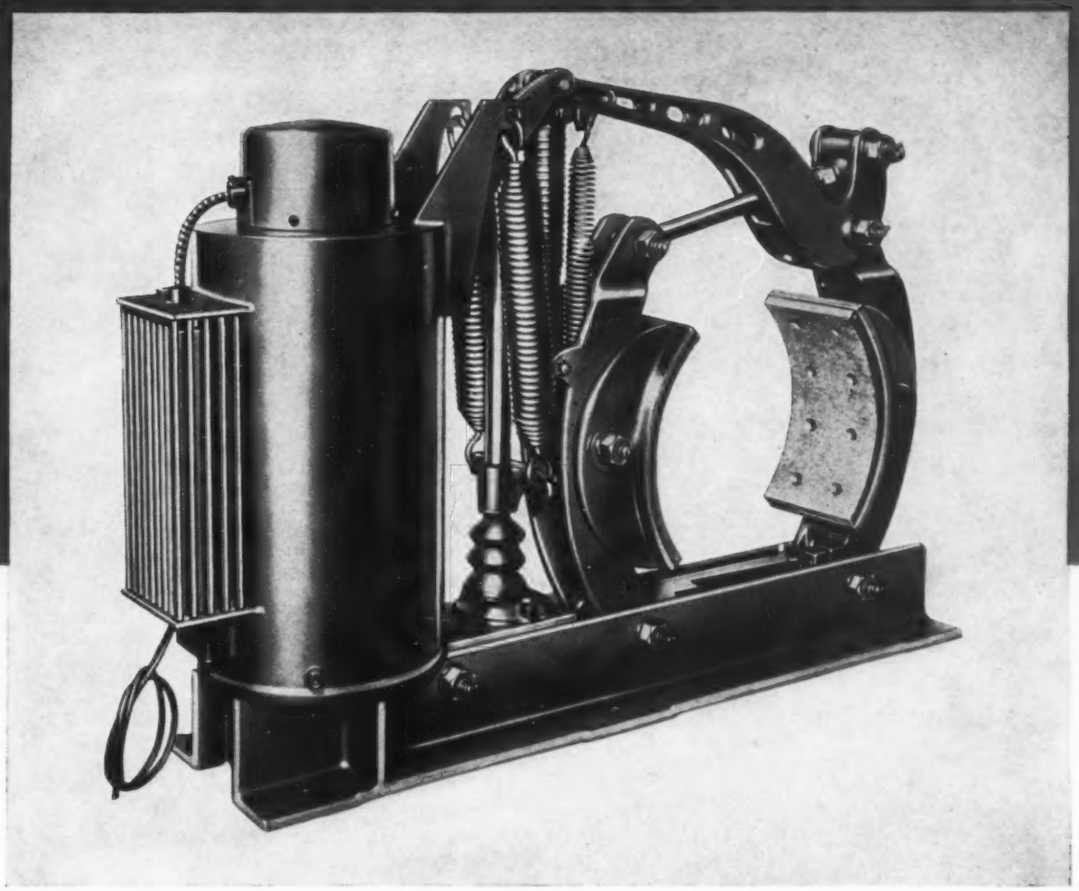
- ONE-POINT ADJUSTMENT
- AUTOMATIC SHOE CLEARANCE
- GREASE FITTINGS ON HINGE PINS
- HARDENED PINS
- PINS KNURLED TO PREVENT ROTATION
- EXTRA-THICK LINING
- NON-SCORING MOLDED LINING
- LINING BOLTED TO SHOES
- SELF-ALIGNING SHOES
- BUILT BY MANUFACTURER OF LOCKHEED HYDRAULIC BRAKES
- NATIONAL SERVICE THROUGH TWENTY-FIVE FACTORY BRANCHES
- ONLY THREE SIZES OF BRAKES AND TWENTY-TWO STANDARD BRAKE WHEELS COVER ALL STEEL MILL CRANE APPLICATIONS

WAGNER HYDRAULIC BRIDGE BRAKE TYPE H

A hydraulically operated foot brake designed for application to the bridge drive of overhead traveling cranes.

The proven advantages of hydraulic bridge braking on overhead traveling cranes are:

1. Smooth powerful braking
2. Accurate stopping
3. Lower foot pedal pressures
4. Quick stops when power fails
5. No mechanical linkage
6. Cab may be mounted on either bridge girder
7. Permits double-bridge braking
8. Motor plugging can be prohibited
9. Lower maintenance costs



WAGNER HYDRAULIC BRIDGE BRAKE TYPE HM

Overhead traveling cranes installed on outside runways exposed to the wind require some means of locking them in position when not in service in order to prevent serious damage that would result from their being blown off the runway during windstorms.

The problem can be solved by installing a shunt-wound magnetic brake, in addition to the hydraulic bridge brake —the hydraulic brake to stop the crane when in service and the magnetic brake to hold the crane from moving when out of service.

The Wagner type HM brake, which is a combination of the hydraulic and magnetic types of brakes, offers a more economical solution because the cost is as much as 32% less than two separate brakes according to size, and the installation cost is reduced 50%.

The well designed shunt-wound solenoid is equipped with protecting switch and discharge resistance. It has sufficient pull to allow the use of powerful springs to set the brake, thereby assuring adequate parking brake torque. The action is entirely automatic.

Coke pushers, coal-charging cars, door machines, and transfer cars are ideal applications for the type HM brakes, because it is desirable that they be held in position on the track when performing their principal function.

The Wagner Plant covers more than 23 acres devoted to the manufacture of brakes, motors and transformers. An experienced engineering staff, modern test laboratories, and the latest type of manufacturing equipment are your assurance of safety and reliability.

Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

MOTORS • TRANSFORMERS • FANS • BRAKES

T40-8A

Typical Wagner air cooled transformer for industrial use. Transformer shown is rated 10 kva, 230/460 to 115/230 volts, 60 cycles, single phase.

Typical Wagner sub-station transformer. Transformer shown is type HEB-K rated 150 kva, 7200 to 2400 volts, 60 cycles, single phase.

Typical Wagner Stud-Bushing type transformer for pole or platform mounting. Transformer shown is type HEB, rated 25 kva, 2400 to 120/240 volts, 60 cycles, single phase.

WAGNER

Distribution Transformers for all Types of Service

Whatever your needs may be, the Wagner line of transformers is so extensive in sizes and types that it includes transformers that will exactly fit your system's service requirements.

Typical Wagner Primary Pocket Stud type transformer for pole or platform mounting. Transformer shown is type HEX, rated 50 kva, 2400 to 120 240 volts, 60 cycles, single phase.

Typical Wagner Stud-Bushing type transformer for pole or platform mounting. Transformer shown is type HEB-K, 50 kva, 13,800 to 2,400 volts, 60 cycles, single phase.

Wagner transformers embody the very latest developments in transformer design and manufacturing methods. They are liberally designed throughout, thus assuring plus performance with maximum efficiency. Wagner transformers help power companies meet the ever-growing demand for greater efficiency. They do their part too, in maintaining the uninterrupted service which is now expected—even demanded of the power supplier.

All over the country Wagner transformers are establishing records for performance and dependability.

In addition to the complete line of distribution transformers Wagner builds power transformers in all sizes and ratings. For complete descriptive literature on the design and construction of Wagner transformers, write for Bulletin TU-180 (Distribution) and TU-181 (Power).

WRITE FOR YOUR COPIES TODAY!

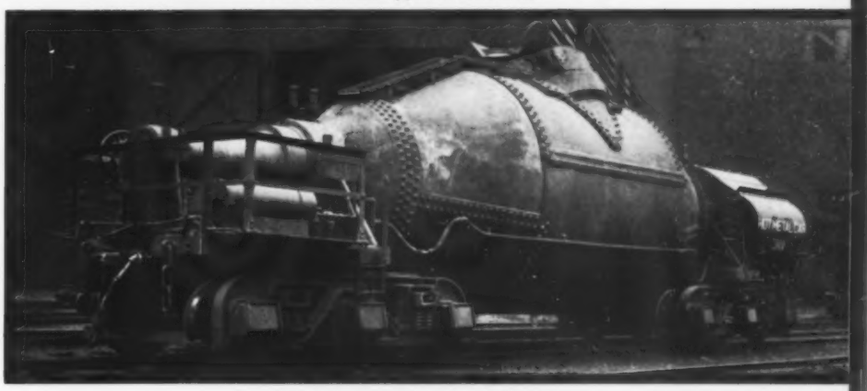
Wagner Electric Corporation

6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

TRANSFORMERS • MOTORS • FANS • BRAKES

TREADWELL

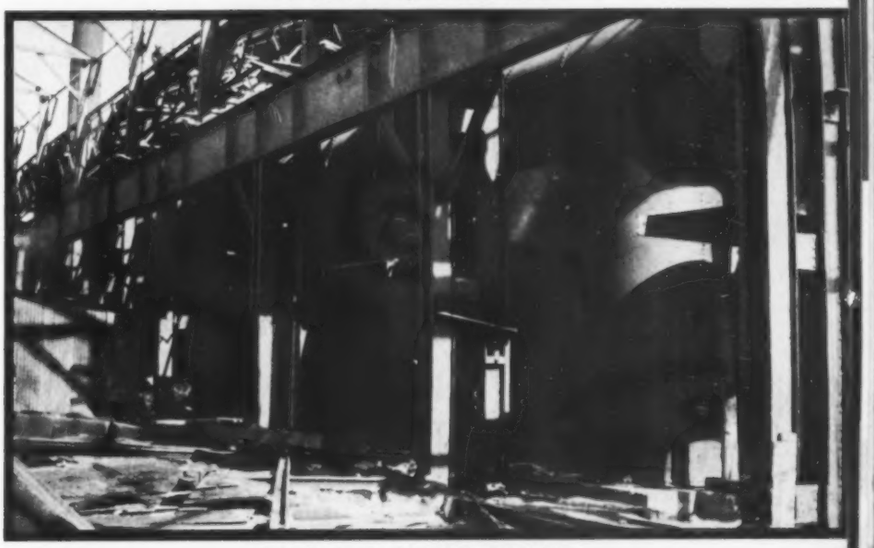
150 Ton Mixer Type Hot Metal Car



Mixer Type Hot Metal Cars
Steam, Air or Motor Dump Cinder Cars for Blast Furnace or Open Hearth Use
Single, Double or Triple Pot Crane Dump Cinder Cars
Scrap Charging Cars

•

Gas Mains for Open Hearth Plants



Welded Ladles
Charging Boxes
Ingot Mold Cars
Stacks
Galvanizing Kettles
Gas Piping
Stand Pipes
General Plate Work

•

Cold Tension Reel for Wide Strip Mill

Cold Rolling Mills
Tables and Transfers
Hot Beds
Coilers
Shears
Merchant Mills
Steel and Iron Castings

M. H. Treadwell Co., Inc.
New York, N. Y.

208 South LaSalle Street
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Treadwell Engineering Co.
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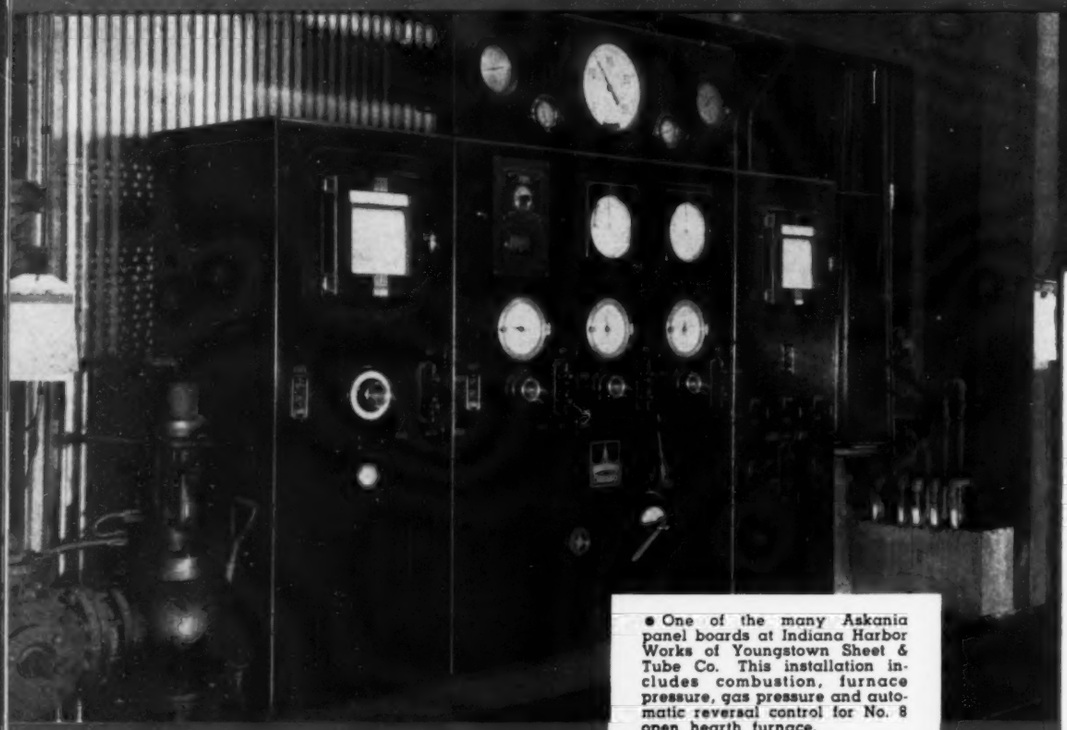
SALES OFFICES
2113 Farmers Bank Building
Pittsburgh, Pa.

Treadwell Construction Co.
Midland, Pa.

140 Cedar Street
New York, N. Y.

It's ASKANIA CONTROL

-right down the line



• One of the many Askania panel boards at Indiana Harbor Works of Youngstown Sheet & Tube Co. This installation includes combustion, furnace pressure, gas pressure and automatic reversal control for No. 8 open hearth furnace.

—at the Indiana Harbor Works of Youngstown Sheet & Tube Co.

YOUNGSTOWN has said it with orders! The list of Askania installations (opposite) reflects the confidence placed in Askania Equipment for the automatic control of vital production processes in the Indiana Harbor Works.

Throughout the steel industry engineers have found that regulating systems built around the exclusive Askania Jet Pipe Principle give a more accurate control in a far simpler way—an advantage that is more appreciated each day the equipment is in service.

WRITE FOR BULLETINS

Askania bulletins convincingly tell the story of Askania principles, Askania progressiveness, Askania leadership. It will pay you to ask for the Askania solution of your control problems.

ASKANIA REGULATOR COMPANY
1603 South Michigan Avenue, Chicago, Illinois

ALL THIS AT YOUNGSTOWN SHEET & TUBE CO.

In the Coke Plant

Control of cross-over main.

Gas mixing station.

Natural gas pressure-reducing stations.

Steam pressure reducing station.

In Tin Mills

Control of box annealing furnaces.

Regulation of gas pressure for tin pots.

In Steel Plant

Combustion and furnace pressure control for soaking pits.

Regulation of gas pressure for soaking pits.

Combustion, furnace pressure, gas pressure and automatic reversal control for open hearth furnaces.

In Merchant Mill

Complete combustion furnace pressure and gas pressure control for merchant mill furnaces.

In 56" Hot Strip Mill

Combustion, furnace pressure and gas pressure control for oil and gas fired 4 zone slab heating furnaces.

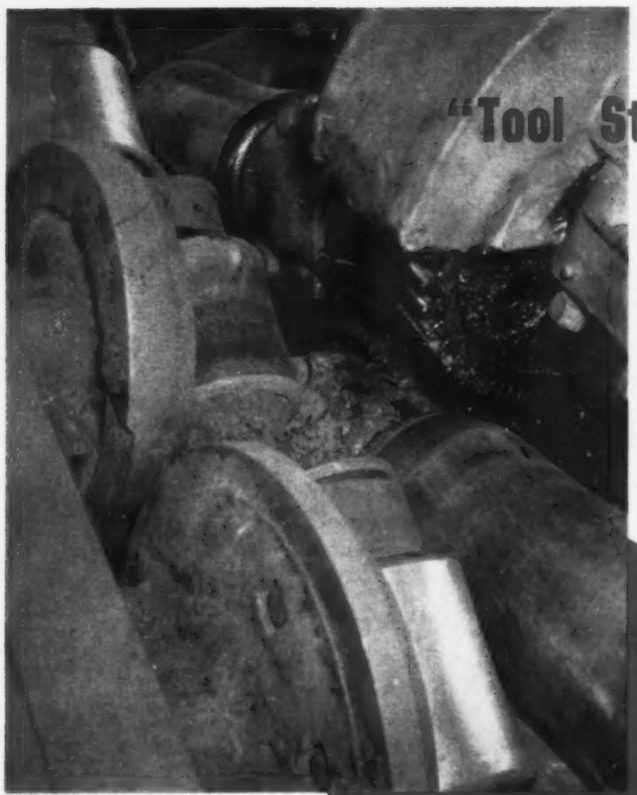
Butt Weld Furnaces

Combustion control, furnace pressure control and gas pressure regulation for Butt Weld furnaces.

ASKANIA CHICAGO

Automatic CONTROL

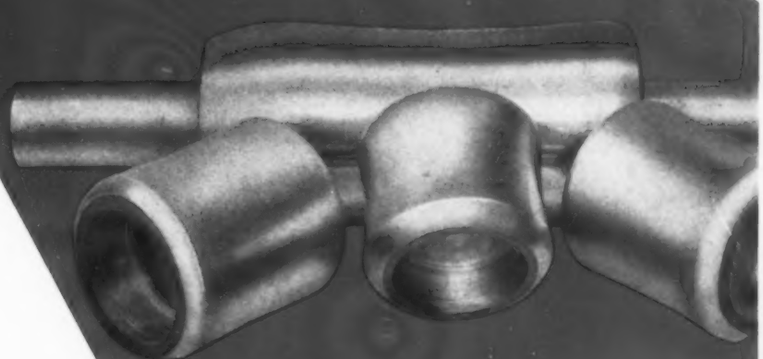
"IF IT CAN BE MEASURED — WE CAN CONTROL IT"



"Tool Steel" Straightening Rolls give Outstanding Service

in Youngstown Sheet & Tube Co.'s Indiana Harbor Plant

Actual photograph of "Tool Steel" hardened rolls in operation in Youngstown's straightening machine after 3 years service.



Rolls previously used lasted from 9 to 12 months, whereas "Tool Steel" rolls have been in service for 3 years and show no wear.

The additional cost of "Tool Steel" rolls has been more than offset by the two years additional life obtained, the decrease in roll maintenance, and the elimination of costly regrinding which is ordinarily necessary.

IT PAYS TO BUY "TOOL STEEL" ROLLS.

THE TOOL STEEL GEAR & PINION CO.

CINCINNATI, OHIO

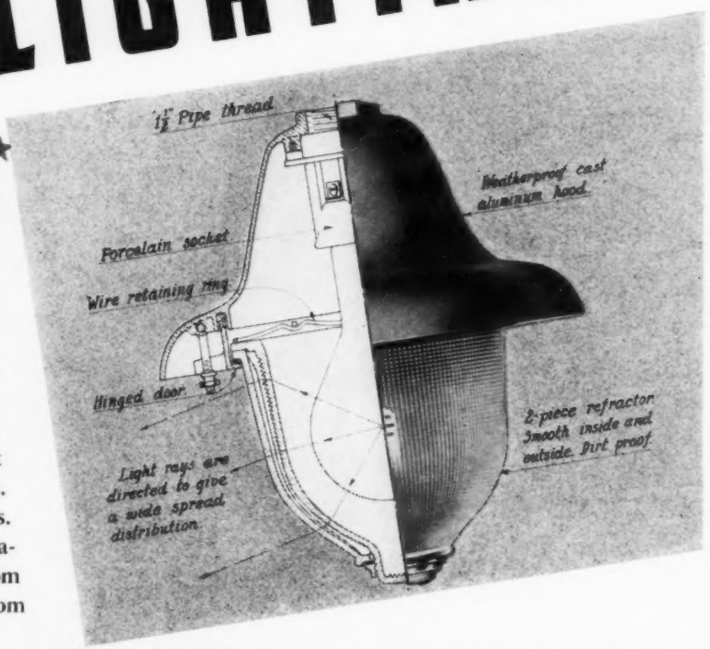
IN TIMES LIKE THESE — *Industry Safeguards its Properties with*

PROTECTIVE LIGHTING

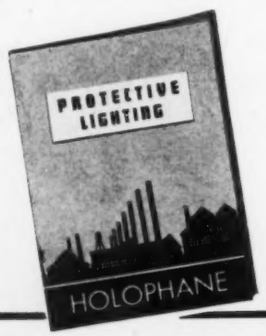
HOLOPHANE REFRACTORS★ provide LOW-COST PROTECTION

(1/10¢ per square foot)

To thwart lawlessness, fire and theft during periods of emergency, plants are installing Holophane Yard Lighting Refractors . . . Specially designed for the use, these units are rugged, dependable and highly efficient for outside night lighting . . . Require no special towers or circuits. Built to withstand the most trying conditions. Trouble-free, dust-proof and resistant to deterioration. Made in sizes to take ordinary lamps from 100 to 500 watts . . . Available immediately from distributors' stocks in your locality.


1½" Pipe thread
Weatherproof cast aluminum hood
Porcelain socket
Wire retaining ring
Hinged door
2-piece refractor Smooth inside and outside. Dirt proof
Light rays are directed to give a wide spread distribution

WITHOUT CHARGE TO YOU *the Holophane Engineering department will send a comprehensive book on protective lighting. Write for it TODAY . . .*



★ PRODUCT OF HOLOPHANE RESEARCH

Holophane

COMPANY, INC. — *Lighting Authorities—Since 1898*

342 MADISON AVE.
NEW YORK CITY

THE HOLOPHANE CO. LTD.
385 Yonge St., Toronto, Canada

Rolls and Rollers

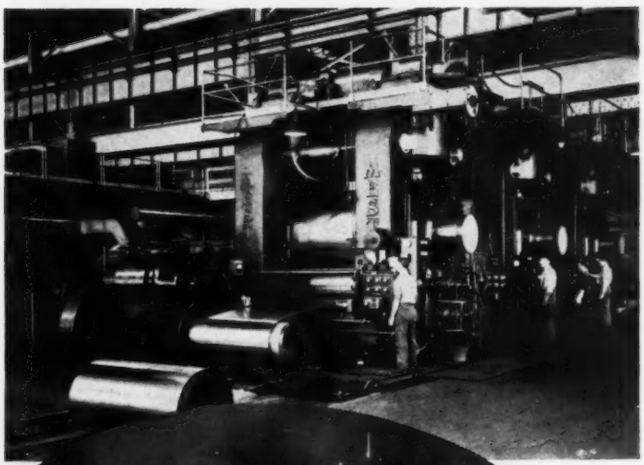
OHIO ROLLS

CARBON STEEL ROLLS	MOLYBDENUM CHILL ROLLS
ALLOY STEEL ROLLS	NICKEL CHILL ROLLS
OHIOLOY "X" ROLLS	FLINTUFF ROLLS
PLAIN CHILLED IRON ROLLS	DENSO-IRON ROLLS
ALLOY IRON ROLLS	NOLL-O-CAST ROLLS

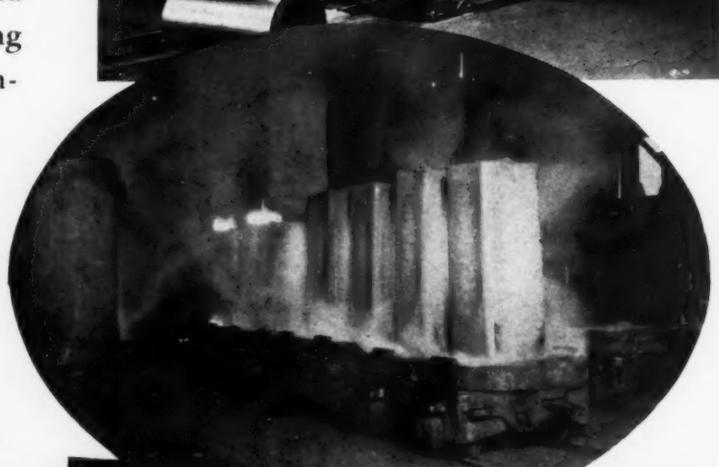
THE OHIO STEEL FOUNDRY CO. LIMA, OHIO

PLANTS – LIMA, OHIO • SPRINGFIELD, OHIO

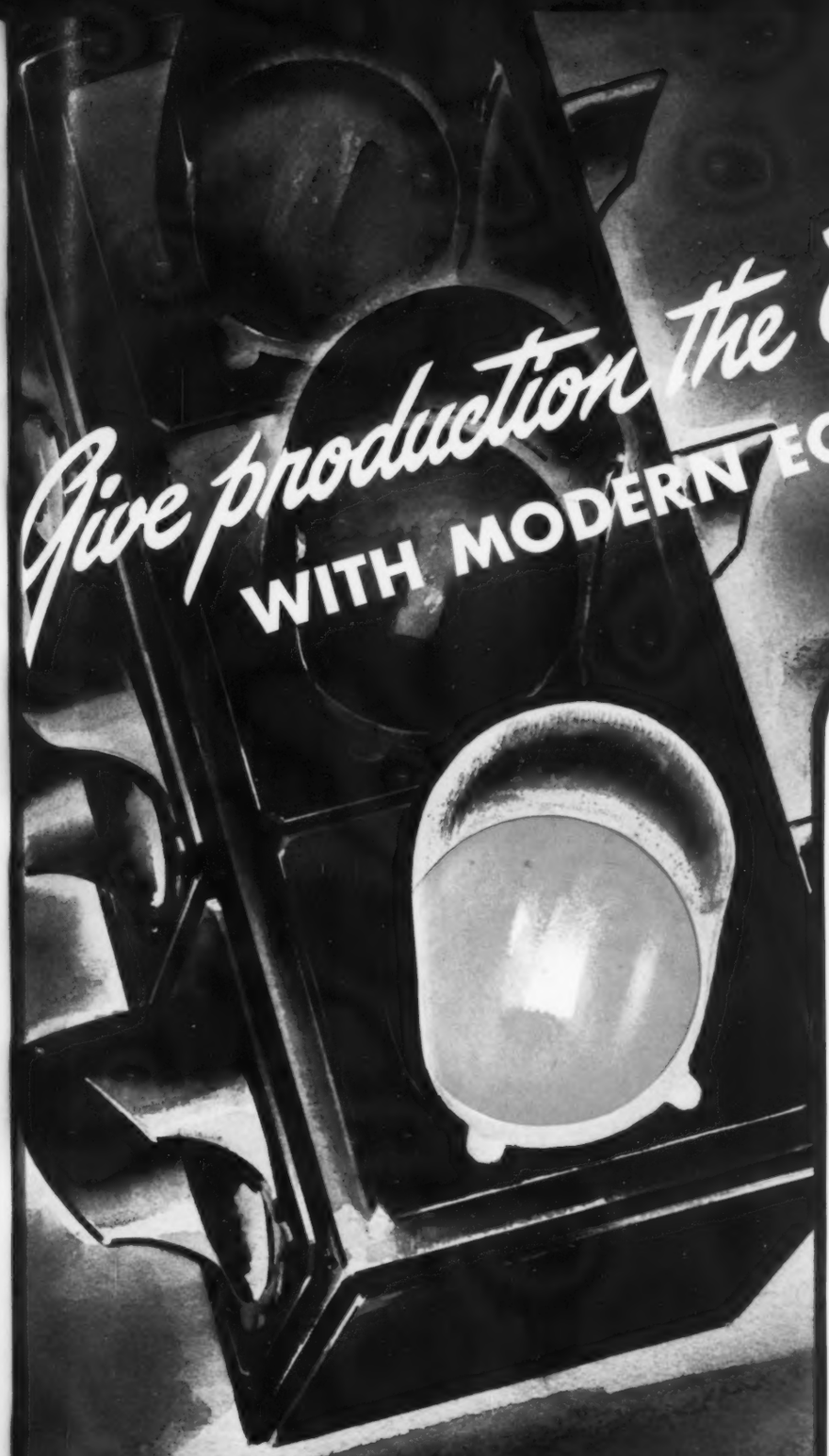
WITH ACCENT ON SAVINGS—Hyatts Are Serving at Youngstown Sheet & Tube



You'll see them on your A. I. & S. E. inspection trip at the Youngstown Sheet & Tube Mill. Preserving machine life . . . eliminating waste, wear, maintenance, replacements and shutdowns. And Hyatt Roller Bearings are doing this same gigantic job of conservation on tables, motors, cranes, cars, etc. everywhere else. For your new equipment or changeovers let Hyatts serve and save for you. Say when and where. Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Chicago, Pittsburgh, Detroit, San Francisco.



HYATT ROLLER BEARINGS



Give production the "GREEN LIGHT"

WITH MODERN EQUIPMENT

We can't expect to meet tomorrow's production needs with yesterday's equipment. Modern processes require up-to-the-minute machines if we are to eliminate the "stops" which inevitably flash a red light on deliveries and costs.

OUR EXPERIENCE CAN HELP YOU

If you are planning modernization, in whole or in part, we can help you on main drives, auxiliaries and other electrical equipment. New mills or machines don't necessarily need complete new drives—often the old ones which have outlived your processes have long years of productive life when properly applied to modern equipment.

For more than 50 years, we have been working side by side with the steel industry to help them maintain schedules, turn out better products and keep down their costs. Our experience and our manufacturing facilities are at your service.

WESTINGHOUSE ELECTRIC & MFG. CO.
EAST PITTSBURGH, PA.

J-94375

Westinghouse

ELECTRICAL PARTNER OF THE STEEL INDUSTRY

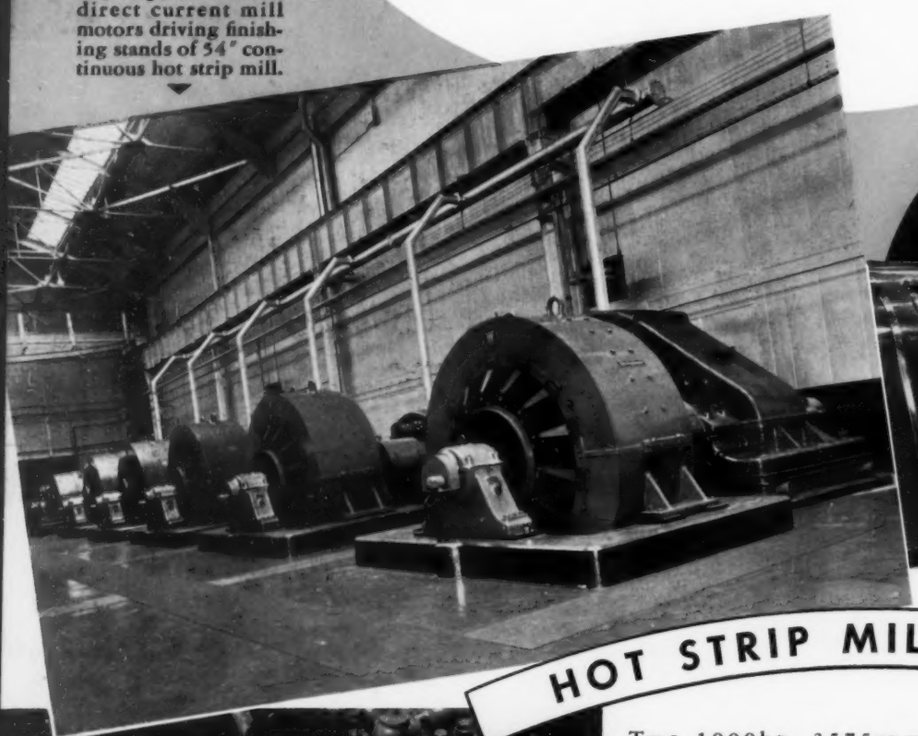
W
WESTINGHOUSE ELECTRIC

AT YOUNGSTOWN SHEET & TUBE CO.

INDIANA HARBOR WORKS

An outstanding example of a modern plant, kept modern. We have been associated over the years with the growth and development of this plant, and have installed many diversified types of equipment to meet the changing processes. This includes both new main drives and auxiliaries, as well as modernization of electrical equipment to fit it to new applications.

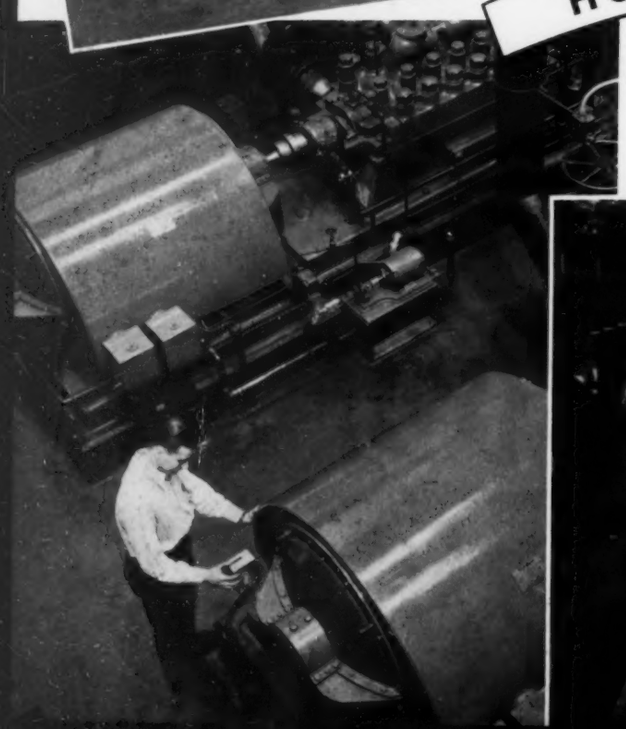
3000hp, 600-volt, direct current mill motors driving finishing stands of 54" continuous hot strip mill.



Generating Station — 10,000 kw high pressure topping turbine and generator unit providing additional power for strip mill development.

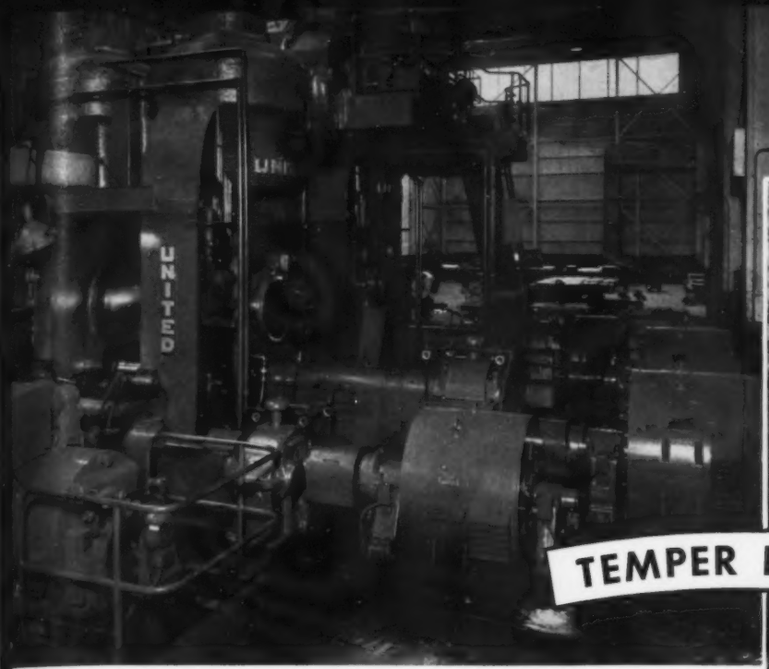
HOT STRIP MILL

Two 1000hp, 3575rpm squirrel-cage induction motors drive the high pressure descaling pumps.



Part of the Metal-Clad Switchgear which controls the 11000-volt and 2200-volt power circuits in the hot strip mill.

A 500,000 kv-a capacity oil breaker unit removed from 11000-volt metal-clad structure for inspection.



TEMPER PASS MILL

The mill, tension device and reel motors for this 42-inch two stand temper mill operate at the roll speeds, eliminating reduction gearing and minimizing inertia with resultant rapid acceleration.

This automatic regulating tensiometer located at the entry side of No. 2 stand controls one of the 350hp mill motors and maintains constant tension on the strip between stands of the mill.

BLOOMING MILL

This reversing motor originally installed in 1918 has been retained and rehabilitated to drive the new 46-inch blooming-slabbing mill which replaces the older mill.

Westinghouse Type SM heavy-duty magnetic control panels are used for the control of the Type MC mill motors driving the screwdowns, main tables, manipulators and slab shear.

MERCHANT MILLS

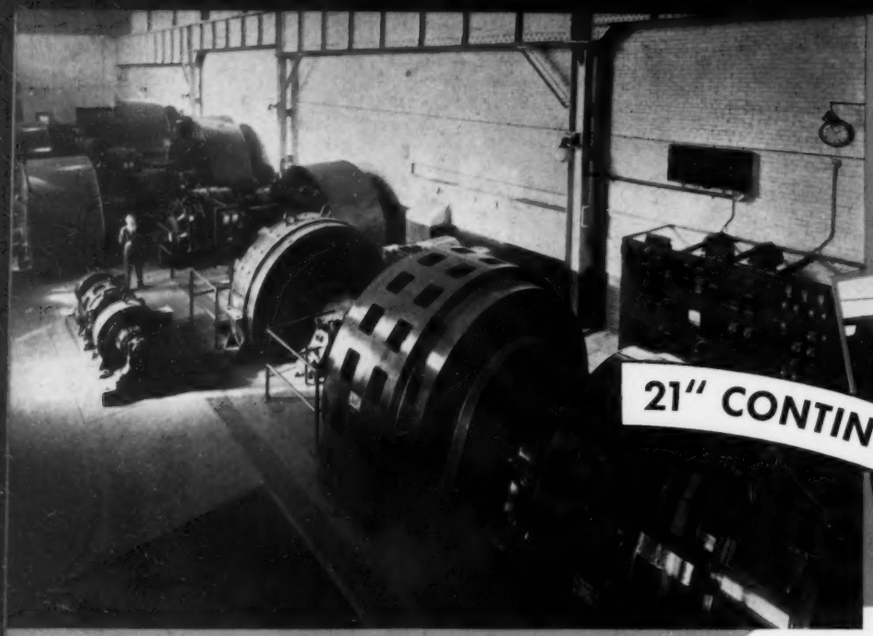
500hp and 1500hp motors driving intermediate and finishing stands of 10-inch merchant mill.

Direct Current power for the 10-inch and 14-18 inch merchant mills is supplied by these three 4000kw motor generator sets.

Westinghouse

ELECTRICAL PARTNER OF THE STEEL INDUSTRY

W WESTINGHOUSE ELECTRIC



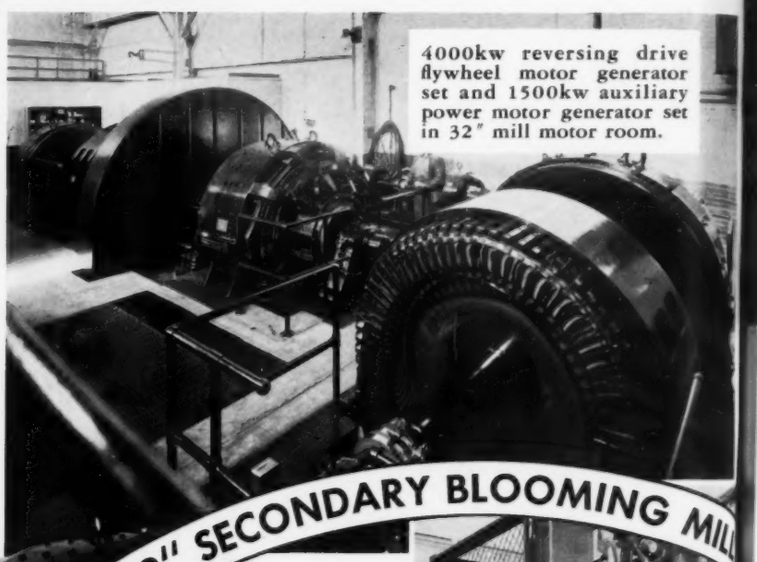
Motor Room showing four 2000hp and two 1500hp, 600-volt dc motors and 7000kw main power motor generator set.

Steel enclosed 6600-volt switchgear controlling 7000kw motor generator set.

21" CONTINUOUS MILL

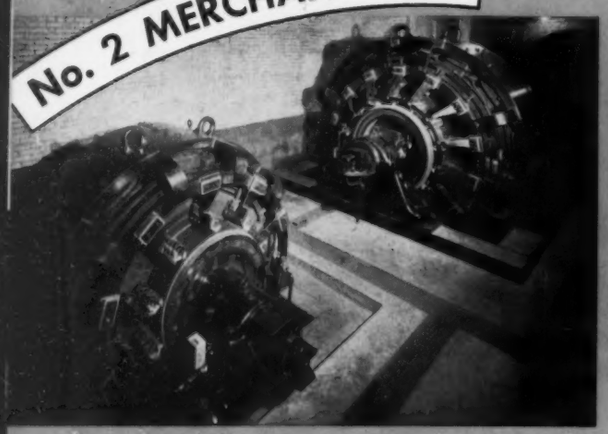
AT WISCONSIN STEEL WORKS OF INTERNATIONAL HARVESTER COMPANY

A further example of Westinghouse co-operation with its steel customers. The electrical equipment pictured here was installed as a result of many years of successful experience with Westinghouse main and auxiliary drives in this plant.



4000kw reversing drive flywheel motor generator set and 1500kw auxiliary power motor generator set in 32" mill motor room.

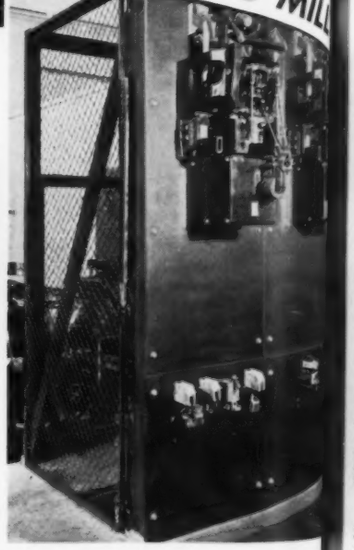
No. 2 MERCHANT MILL



1500hp, 300/600rpm and 3500hp, 175/350rpm, 600-volt direct current adjustable speed motors. Two additional 1500hp motors (not shown) drive other stands of the No. 2 merchant mill.

32" SECONDARY BLOOMING MILL

4000hp, 75/165rpm, 700-volt reversing motor—which drives the 32-inch secondary blooming mill.

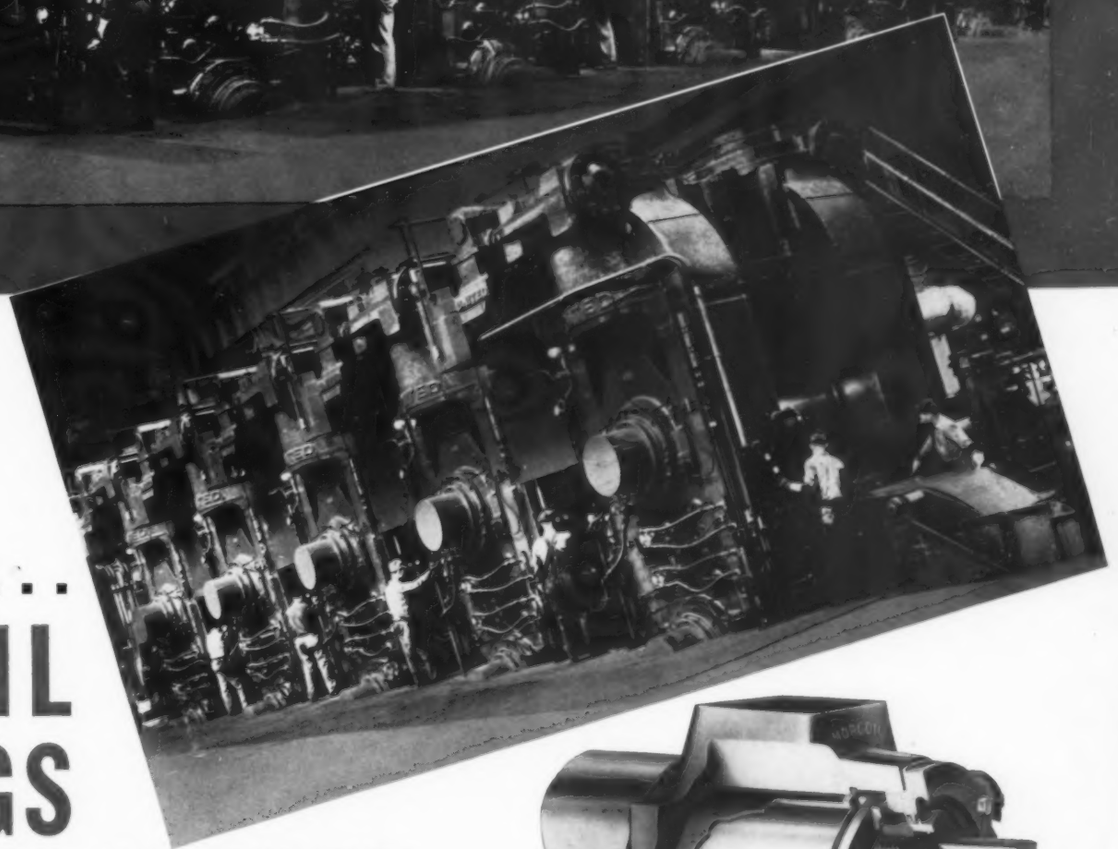


The 4000hp mill motor and the two 2000 kw main supply generators are protected by these Type CHM high-capacity air circuit breakers in the tie circuit.

Westinghouse

ELECTRICAL PARTNER OF THE STEEL INDUSTRY

W WESTINGHOUSE ELECTRIC



Two views of the 5-stand tandem cold mill equipped with 42" - 72 MORGOILS. Indiana Harbor Works, Youngstown Sheet & Tube Co.

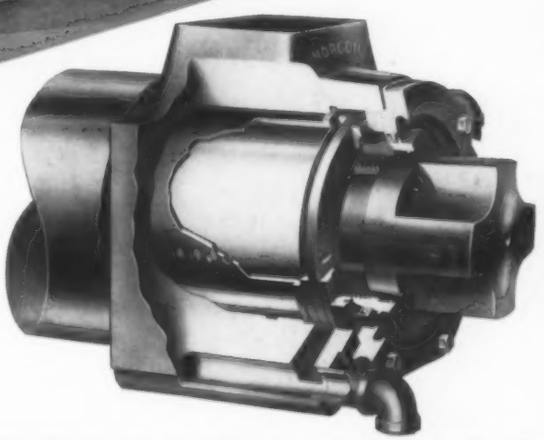
YOU'LL SEE . . .
MORGOIL BEARINGS
AT INDIANA HARBOR

The amazing load carrying capacity of a film of oil maintained under pressure between two highly polished surfaces is again demonstrated in this tandem cold mill.

Morgoil Roll Neck Bearings are becoming standard equipment on rolling mills of all types, sizes and capacities. They may also be installed in existing mills. Send for the Morgoil book—free.

MORGAN CONSTRUCTION COMPANY · WORCESTER, MASS.

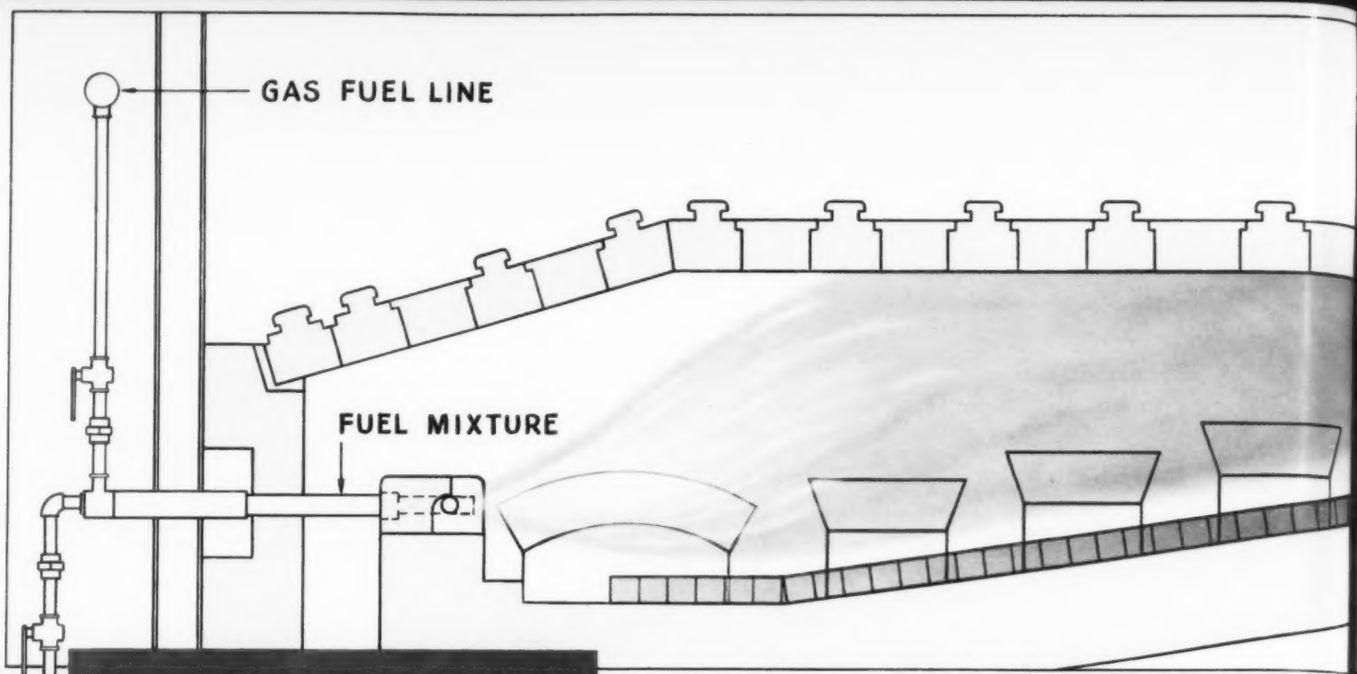
R-79

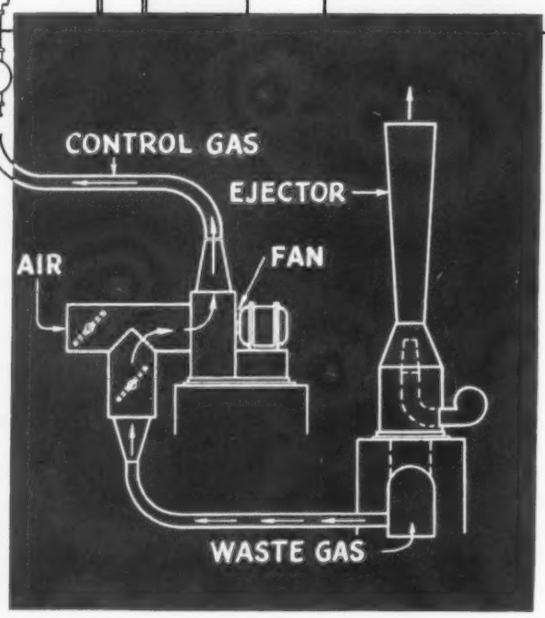


MORGAN
WORCESTER
ENGINEERS AND
MANUFACTURERS

CONTINUOUS ROLLING MILLS

ROD · STRIP · SKELP · MERCHANT SHAPES





TO THE STEEL INDUSTRY COMES AN

MORGAN CONTROLLED

Uniform Luminosity Radiates Heat over Entire Hearth

Insert shows motor-operated fan with controlled intakes connected both to the flue (for waste gases) and to atmosphere. Proportions may be changed at will. Flame adjustment is quick and sure and may be made at any time without affecting the total heat of the furnace.

WHILE the basic advantages of Luminous Flame Firing in reheating billet furnaces and soaking pits are well recognized, the incomplete combustion and lack of control inherent in present systems have prevented full use of this radiant energy.

Morgan *Controlled* Luminous Flame overcomes these difficulties. It has the shape and direction of a sharp flame but burns with maximum luminosity, releasing radiant energy throughout its length. It effects complete combustion. Its shape and size may be controlled at will, as shown in these four illustrations.

Length and shape are effected by the utilization of a "control" gas mixture introduced into the fuel gas before it enters the port. Composition of the "control" gas may be 100% air, 100% waste gas from the stack flue, or any needed proportion of air and waste gas. An increase in the proportion of air in the "control" mixture shortens the flame; an increase in the proportion of waste gas lengthens the flame by delaying combustion. Complete combustion is always secured, however.

* * *

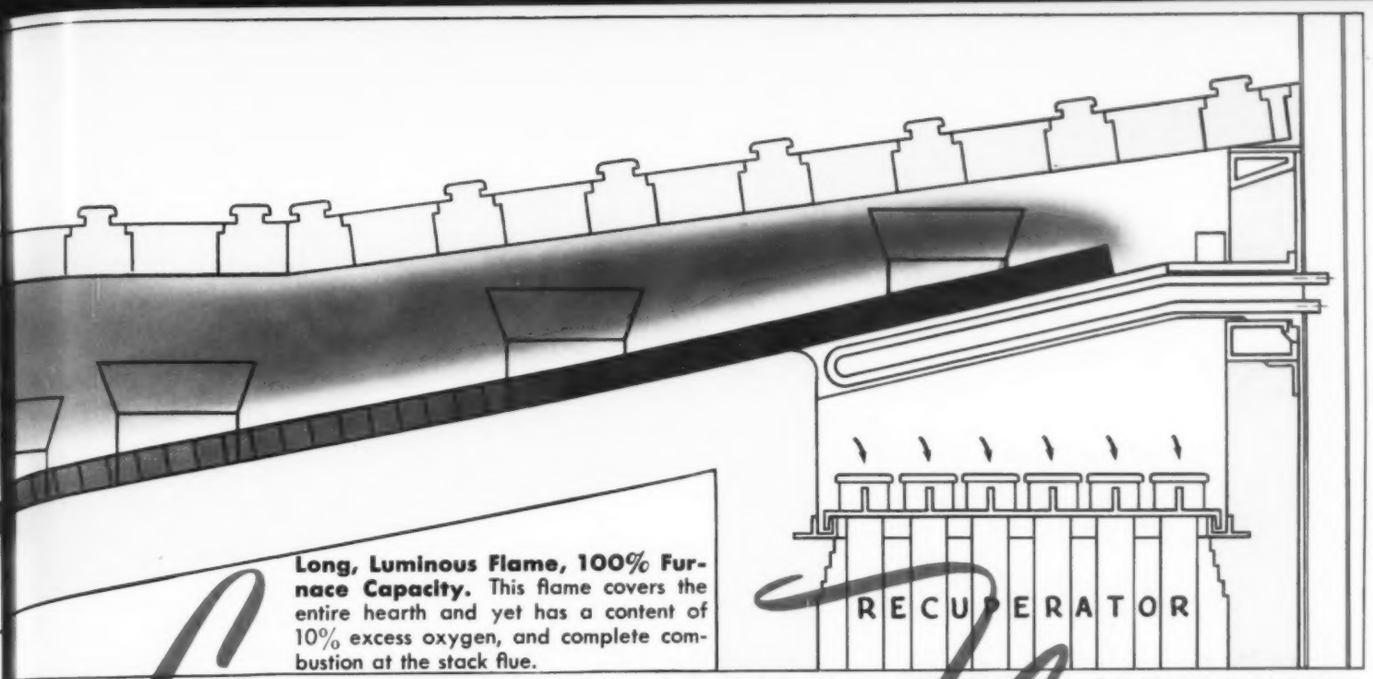
Morgan engineers are ready to study your furnace and discuss the application of Luminous Flame Control System. Take advantage of this sound, tested method for greater heating efficiency. Send for free copy of bulletin.

V-2

MORGAN WORCESTER ENGINEERS AND MANUFACTURERS

MORGAN CONSTRUCTION

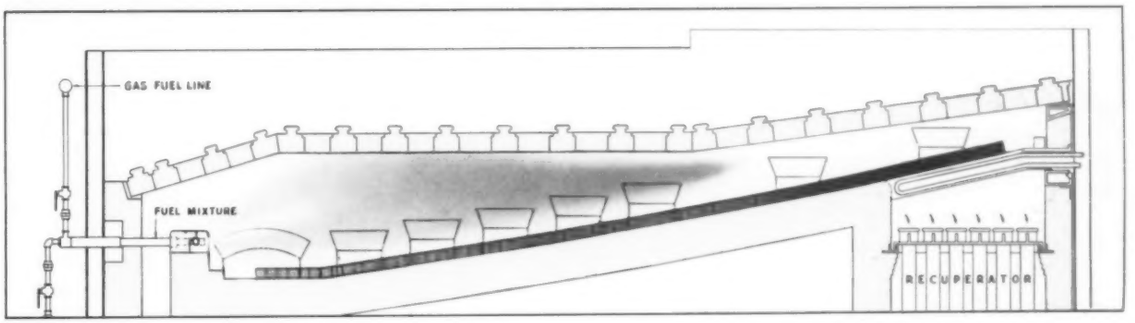
ISLEY FURNACE SYSTEM ... CONTINUOUS ROLLING



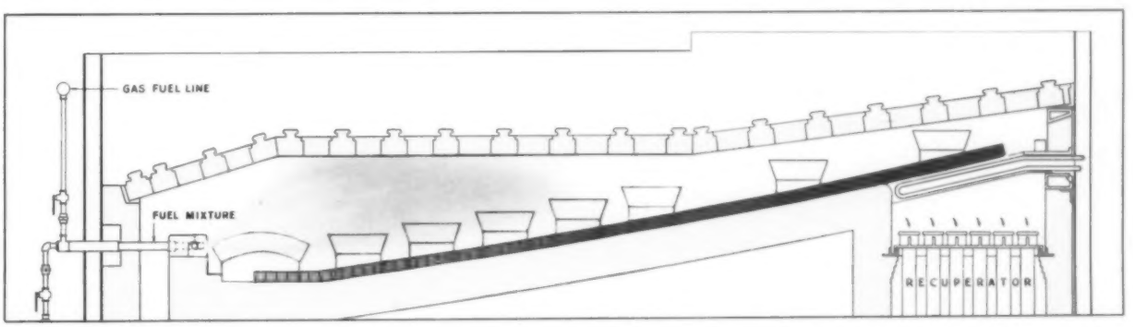
Long, Luminous Flame, 100% Furnace Capacity. This flame covers the entire hearth and yet has a content of 10% excess oxygen, and complete combustion at the stack flue.

ANOTHER MORGAN ADVANCE IN REHEATING FURNACE COMBUSTION

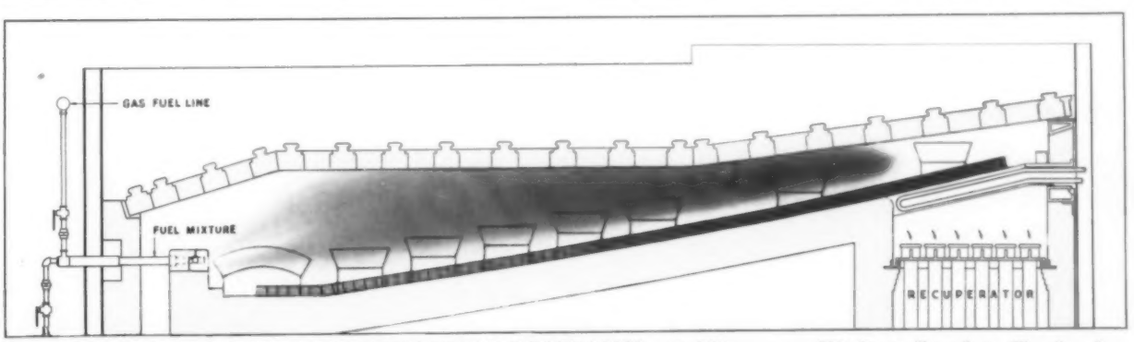
Luminous Flame*



Three-quarter Length Luminous Flame, 100% Furnace Capacity. This flame has length with moderate radiant temperature at the bridge wall.



Short, Luminous Flame, 100% Furnace Capacity. This flame has full radiance but its shape and direction are controlled to direct its radiant heat into lower part of furnace.



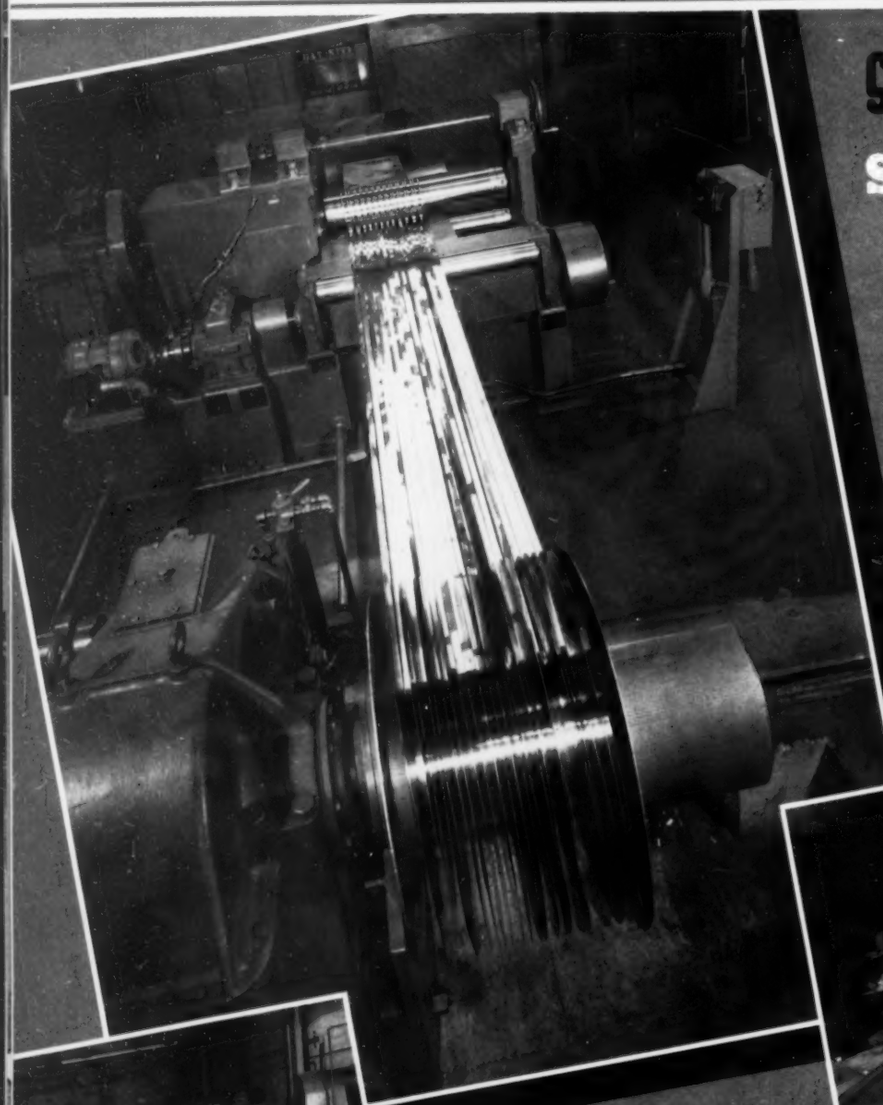
Long, Luminous Flame, 50% Furnace Capacity. This flame extends across entire hearth, but its radiant heat is only 50% as great as that of flames shown above. It develops the uniform temperature required for efficient operation of the furnace at reduced capacity.

Licensed under Toledo Engineering Co., Inc. Patents

English Representative: INTERNATIONAL CONSTRUCTION COMPANY, 56 Kingsway, W. C. 2, London, England

COMPANY · WORCESTER · MASS.

MILLS ... PRODUCER GAS MACHINES ... WIRE DRAWING MACHINERY



STAMCO *Presents a* SLITTING LINE *for* STRIP STEEL

Designed and built by STAMCO for the steel and metalworking industries, this modern Slitting Line and its complete controls performs a quick, highly accurate slitting job on strip steel . . . Cutters on the unit proper and separation discs on the power driven reel are adjustable to accommodate up to 26 cuts on a given width. Operating speeds up to 600 feet per minute may be obtained . . . Complete construction and operating details are available to those interested.

The STREINE TOOL & MANUFACTURING COMPANY

DESIGNERS AND BUILDERS OF STAMCO SHEET AND PLATE MACHINERY

STAMCO

NEW BREMEN, OHIO

YALE *serves the Steel Industry*

...THAT IT MAY BETTER SERVE AMERICA

The eyes of the world are focused on America and the Defense Program. Backbone of this program is the Steel Industry. Outstanding example of the American way, Steel has always been equal to the occasion, and is again ready to meet the challenge

Aiding Steel in solving its problem of materials handling has been The Yale & Towne Manufacturing Co. In every crisis during the past 75 years, Yale has been ready with tools to eliminate the bottleneck of materials handling.

In this emergency Yale is again ready For as Steel enlarged its plants, prepared for greater production, Yale foresaw the trend, built handling equipment to care for the greater need.

One outstanding example of such equipment is the giant Yale ram truck illustrated. Built to care for the demands of just one phase of Steel's handling—that in the continuous mills—it is apace of the evolution that has occurred in the last five years.

This Yale "Quarter Mile Champion" Ram Truck, one of a fleet, was built to handle coils of steel ¼ mile in length and up to 25,000 lbs. in weight. In continuous daily service at the Indiana Harbor Works of the Youngstown Sheet and Tube Co., these trucks help keep handling problems . . . *and costs* to a minimum.

Any Yale representative will be glad to discuss your handling problems with you, give you full information how Yale Equipment can speed *your* operations and cut *your* costs. Get in touch with him today or write to us.

•

Capacities up to 50,000 lbs.

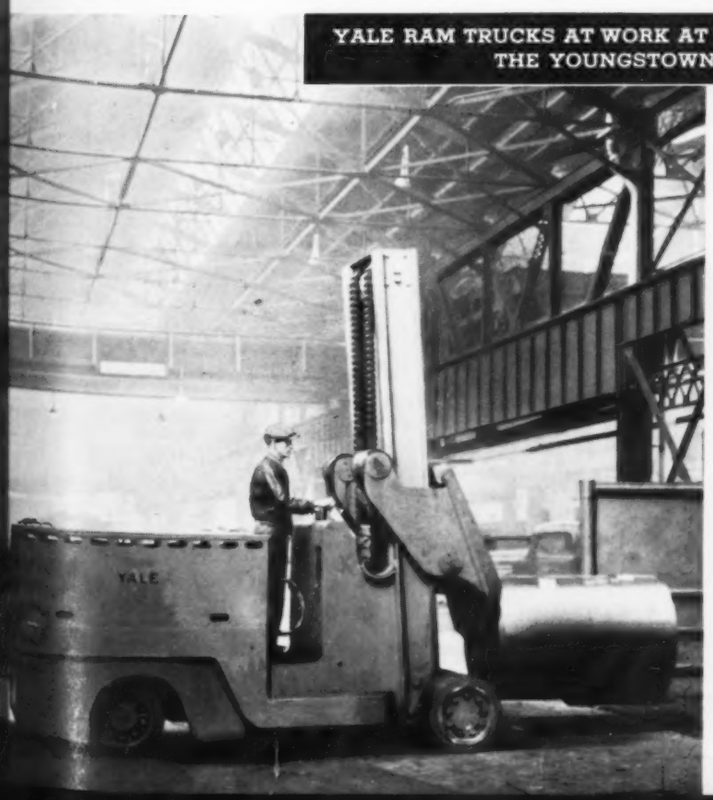
THE YALE & TOWNE MFG. CO.

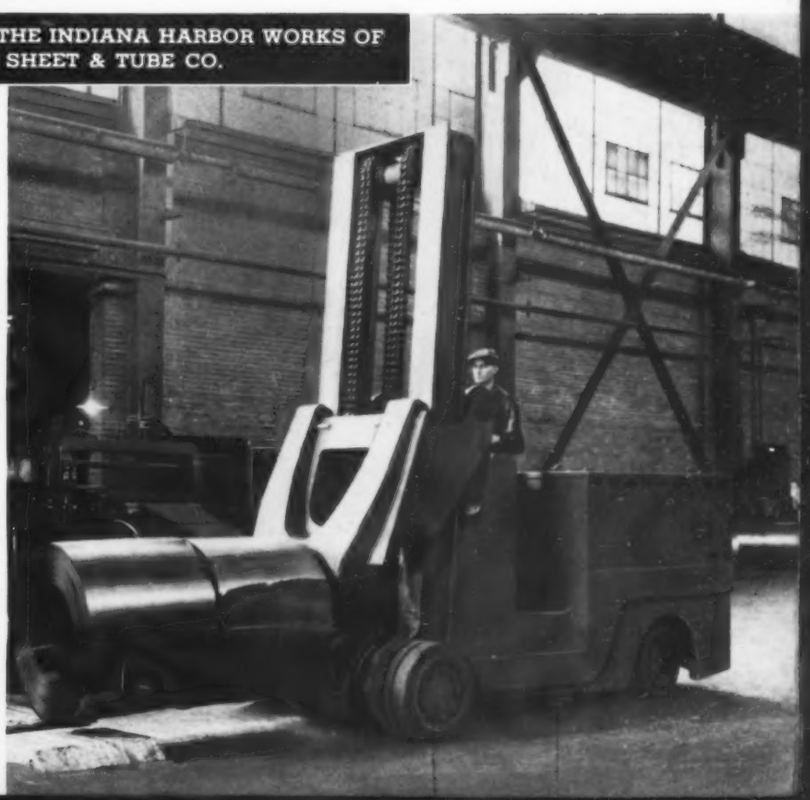
PHILADELPHIA DIVISION
PHILADELPHIA, PA., U. S. A.

IN CANADA
ST. CATHARINES, ONT.

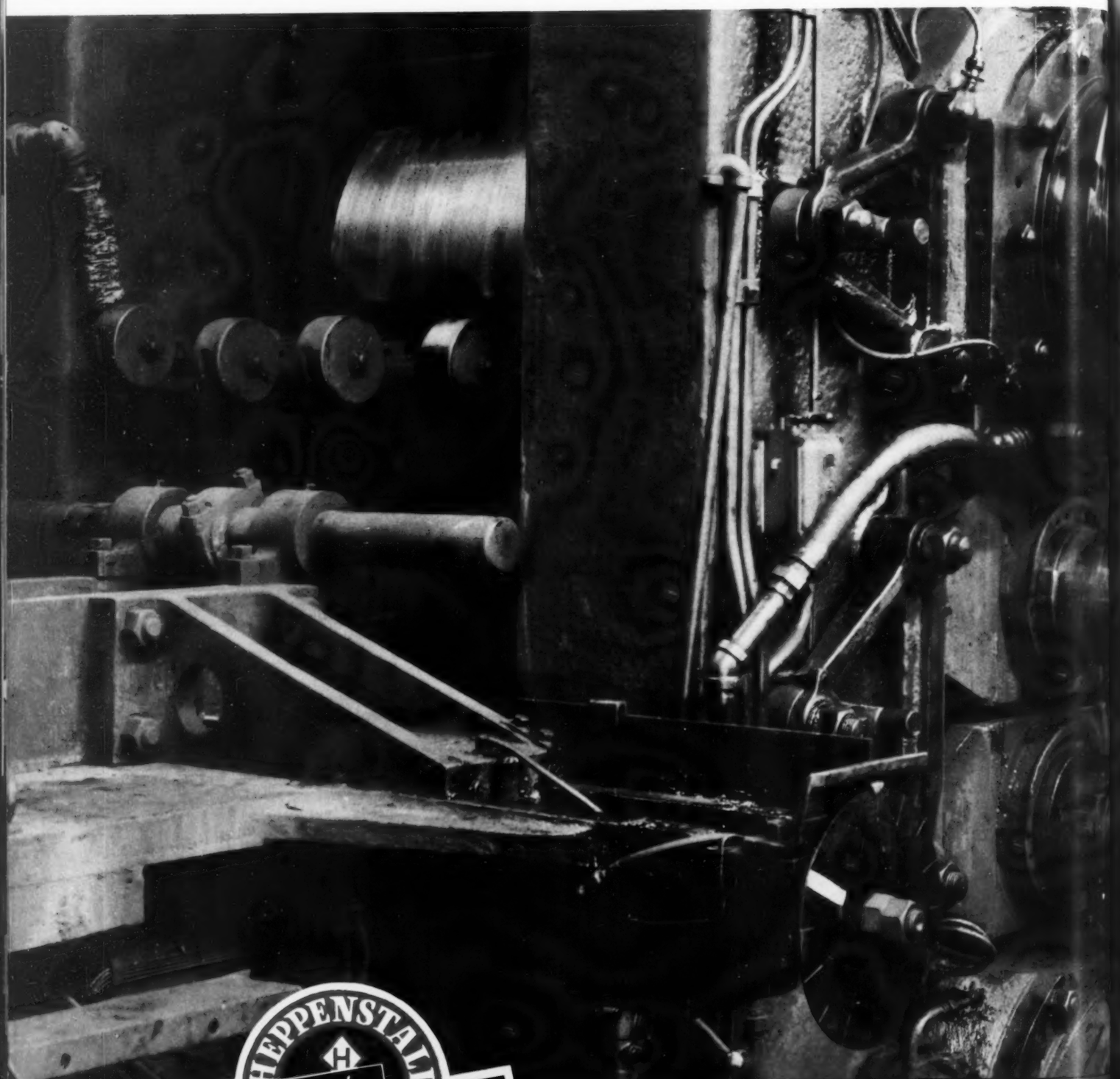
YALE

YALE RAM TRUCKS AT WORK AT THE INDIANA HARBOR WORKS OF THE YOUNGSTOWN SHEET & TUBE CO.





Heppenstall Products Serve Indiana Harbor Plant



HEPPENSTALL
Heppenstall has the Experience
QUALITY

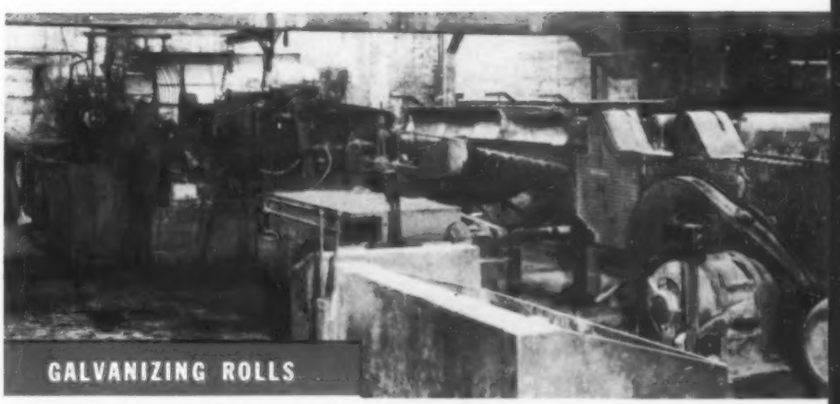
SLEEVE-TYPE BACK-UP STRIP MILL ROLLS

Heppenstall forged alloy sleeves shrunk on your scrap back-ups will out perform the original cast rolls.

# of The Youngstown Sheet and Tube Company

HEPPENSTALL is serving the entire Steel Industry with die blocks, gripper dies, shear knives, forgings, rolls and other products of fine steel. Back of every Heppenstall product there are 148 years of iron and steel experience.

If you have forging, shearing, crank, roll, shaft or lifting problems that are causing you trouble and expense, you can benefit from the superior properties that Heppenstall builds into every product. For full details, ask for a Heppenstall engineer to call.



GALVANIZING ROLLS

Heppenstall special analysis exit and bottom galvanizing rolls. Heppenstall tinning and galvanizing rolls are standard equipment in 90% of the mills in this country.

GELLERT TONGS

FASTER, SAFER, SURER! In any plant where material is handled by crane or hoist, Gellert Tongs remove one of the greatest hazards to employee life and limb, and one of the most serious causes of lost time.

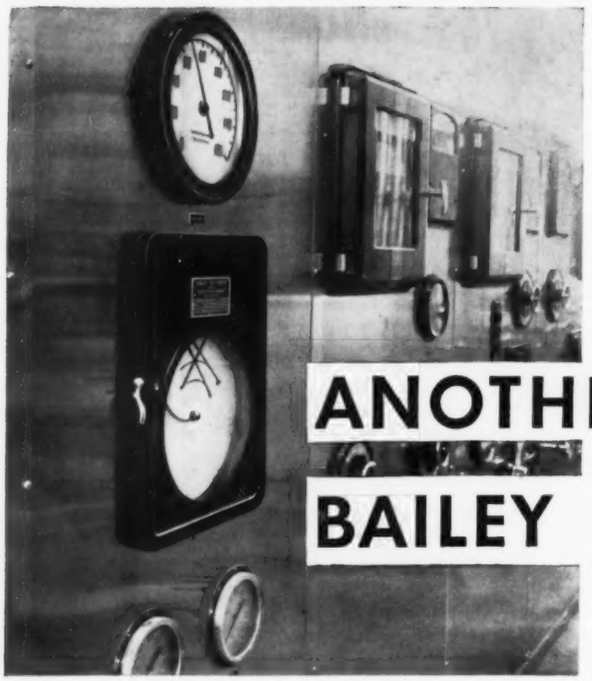
There are Heppenstall Shear Knives, manufactured in Heppenstall electric, induction furnaces, for all types of shearing —Kleenkut, Hotkut, Durkut, Slabkut, Bloomkut, Heviduty and Standard.

SHEAR KNIVES

HEPPENSTALL PRODUCTS: Die Blocks . . . Shear Knives . . . Hammer Rams . . . Piston Rods . . . Tinning and Galvanizing Rolls . . . Gellert Tongs . . . Locomotive Axles, Pins and Rods . . . E.I.S. and O.H. Alloy Steels . . . Carbon and Alloy Forgings.

HEPPENSTALL COMPANY

PITTSBURGH · BRIDGEPORT · DETROIT



ANOTHER MILL INSTALLS BAILEY METER CONTROL

Gas Flow to an Annealing Furnace is Indicated and Recorded by this Bailey Meter.

Automatic Operation Insures Added Fuel Economy, Boiler Safety and Plant Reliability

● At Indiana Harbor, Youngstown Sheet & Tube Company is capitalizing on the additional fuel economy, safety of operation, and continuity of service made possible by Bailey Meter Control. Here the two new pulverized coal fired boilers are provided with both Three-Element Feed Water Control and complete Combustion Control.

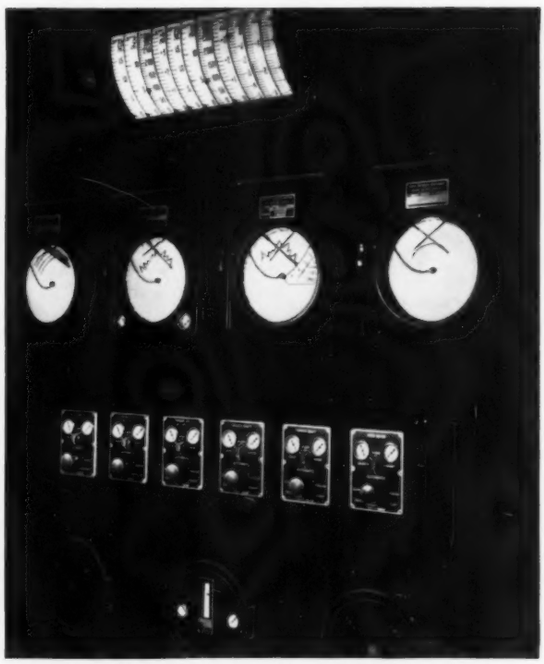
As an integral part of the control system, the Bailey Boiler Meter sees combustion changes as they occur and with a true eye to economy, automatically operates the control, readjusting air as required to maintain best combustion conditions within the boiler furnace at all times.

Regardless of the fuel or the combination of fuels, boiler plants ranging in size upward from 200 h. p. are being operated continuously at test efficiencies by Bailey Meter Control.

Youngstown Sheet & Tube Company also uses Bailey Gas Meters to insure accurate measurement of fuel for metallurgical furnaces.

A-55

BAILEY METER COMPANY
1047 IVANHOE ROAD, CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada

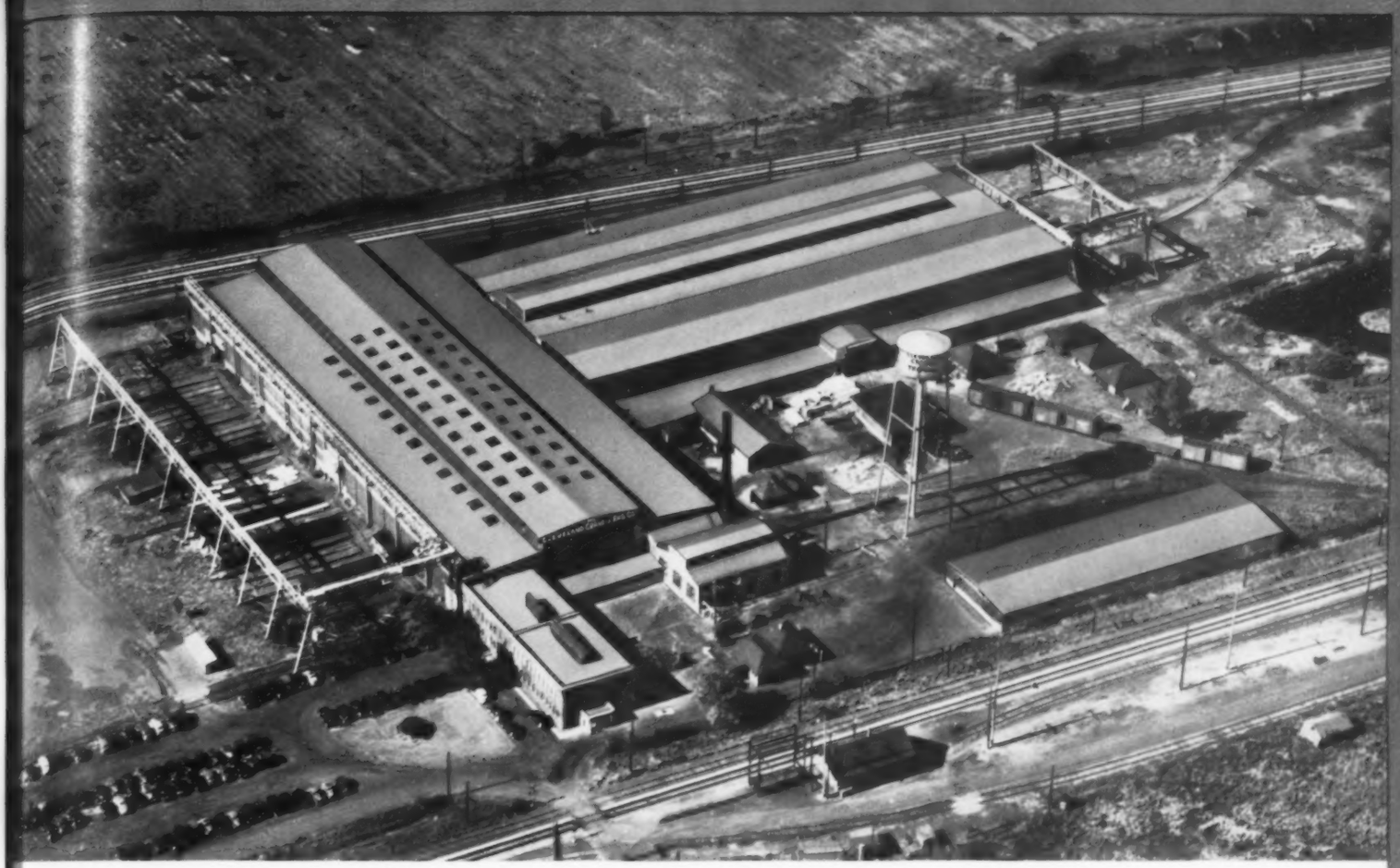


Automatic Control of the New Indiana Harbor Boilers Centers at this Bailey Meter Control Panel.

BAILEY METER COMPANY

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL



Main office and factory of The Cleveland Crane & Engineering Co., Wickliffe, Ohio

★ ★ ★ THREE DIVISIONS

EACH A LEADER IN ITS FIELD

3

CLEVELAND CRANE DIVISION

For 40 years builders of overhead traveling cranes. Originator of Cleveland All-Welded Cranes—now in 14th year—still the only manufacturer featuring this modern and proven construction.

CLEVELAND TRAMRAIL DIVISION

World's Largest Builder of Tramrail Materials Handling Equipment. Complete Line, Hand Power or Electric for every purpose.

STEELWELD MACHINERY DIVISION

Builder of the most modern Bending Presses and Bulldozers available today. Steelweld Machinery is in use the world over.

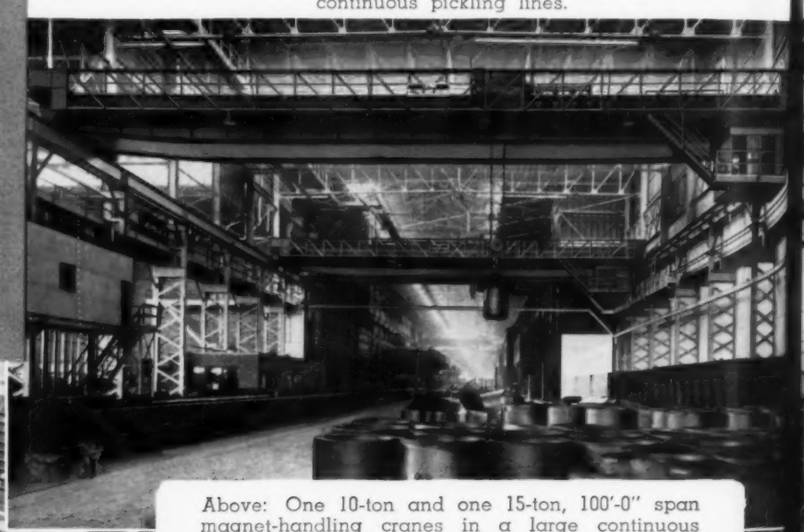
THE CLEVELAND CRANE & ENGINEERING CO.

WICKLIFFE OHIO

Cleveland Cranes

ALL WELDED OVERHEAD TRAVELING CRANES

Two 15-ton, 100'-0" span steel mill cranes operating over continuous pickling lines.



Above: One 10-ton and one 15-ton, 100'-0" span magnet-handling cranes in a large continuous strip mill.

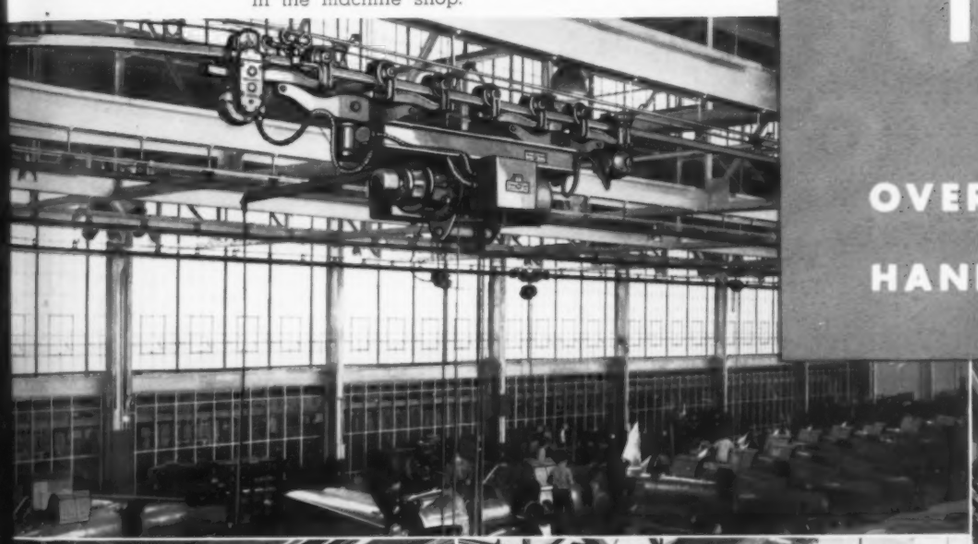
World's longest span all-welded crane. 15-ton, 120'-0" span. One of 15 duplicate cranes on one order.

THE CLEVELAND CRANE &

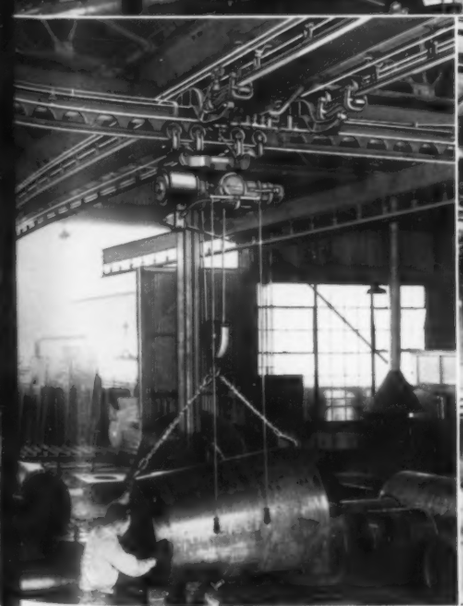
Cleveland Tramrail hand-propelled cranes with motor-driven hoists in the machine shop.

Cleveland Tramrail

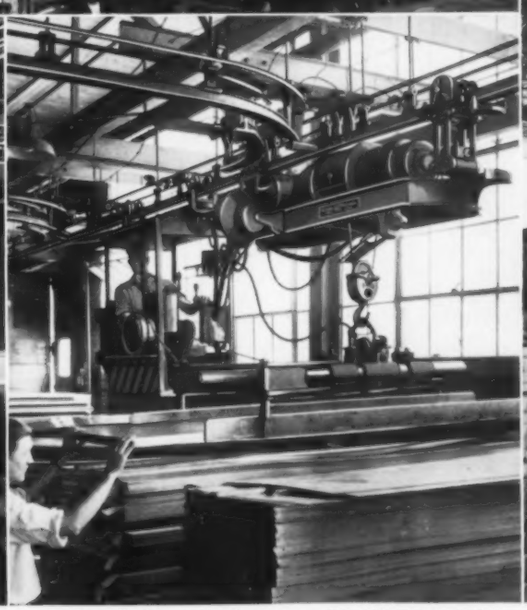
OVERHEAD MATERIALS HANDLING EQUIPMENT



Left: In many aeroplane factories complete plant coverage is obtained with Cleveland Tramrail motor-driven hoists and carriers.



this structural shop crane interlocks are ed to permit transferring the load from crane to crane.



Packs of sheet steel are easily taken to and from storage by this cab-controlled Cleveland Tramrail system with motor-operated grab.

Handling 32-100 lb. kegs per lift. Interlocks permit transferring cab-operated hoist and carrier to crane bridge in next bay.

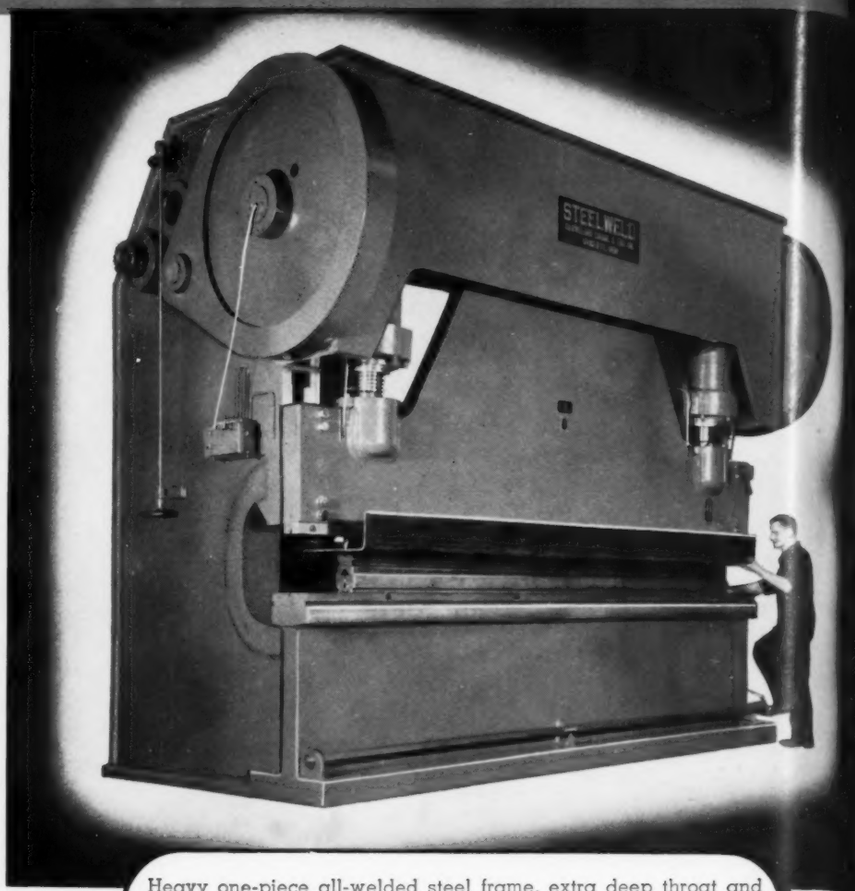
E & ENGINEERING CO., Wickliffe, Ohio

Steelweld Machinery

BENDING PRESSES

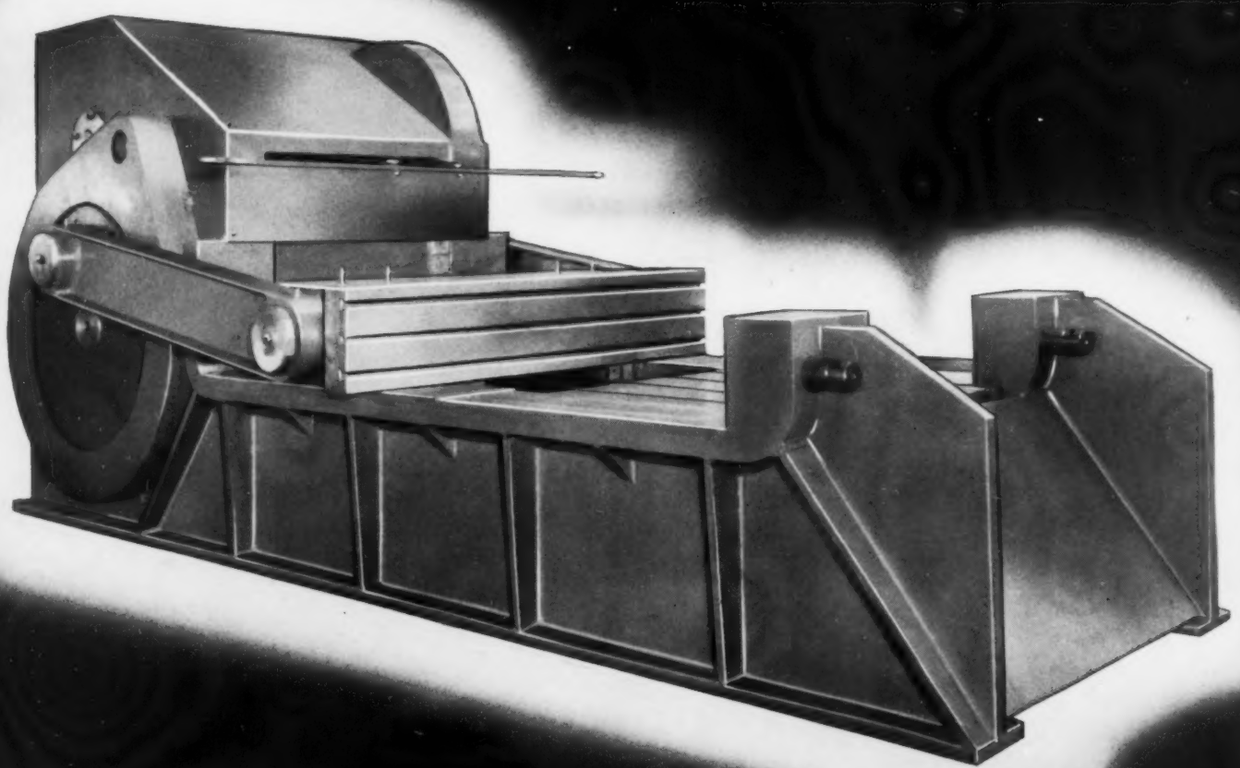
BULLDOZERS

SPECIAL MACHINERY



Heavy one-piece all-welded steel frame, extra deep throat and many other exclusive features make Steelweld Bending Presses the most modern and versatile available today.

For heavy power requirements Steelweld Bulldozers cannot be excelled. When driven by proper motor their all-welded frames are guaranteed unbreakable. Every part is built for years of trouble-free service.



The Steelweld Machinery Division is represented by Cyril Bath & Co., General Sales Agents, East 70th St. and Machinery Ave., Cleveland, Ohio

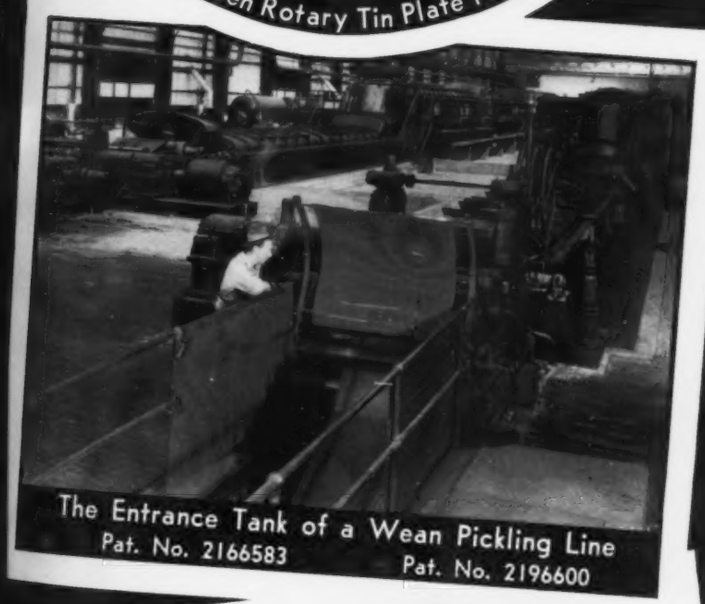
THE CLEVELAND CRANE & ENGINEERING CO.

WICKLIFFE OHIO

THE WEAN ENGINEERING CO. Inc
WARREN, OHIO

Wean-Hallden Rotary Tin Plate Flying Shear

Wean Galvanizing Units

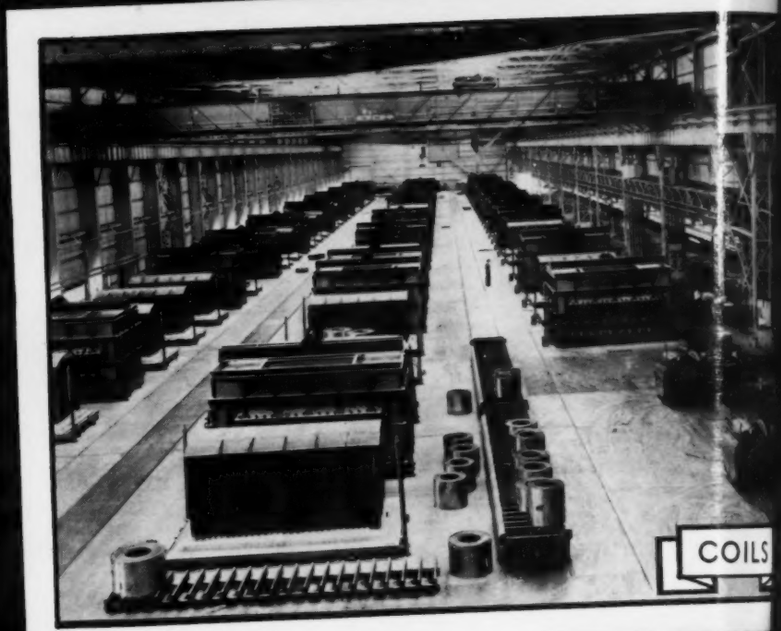

The Entrance Tank of a Wean Pickling Line
Pat. No. 2166583 Pat. No. 2196600

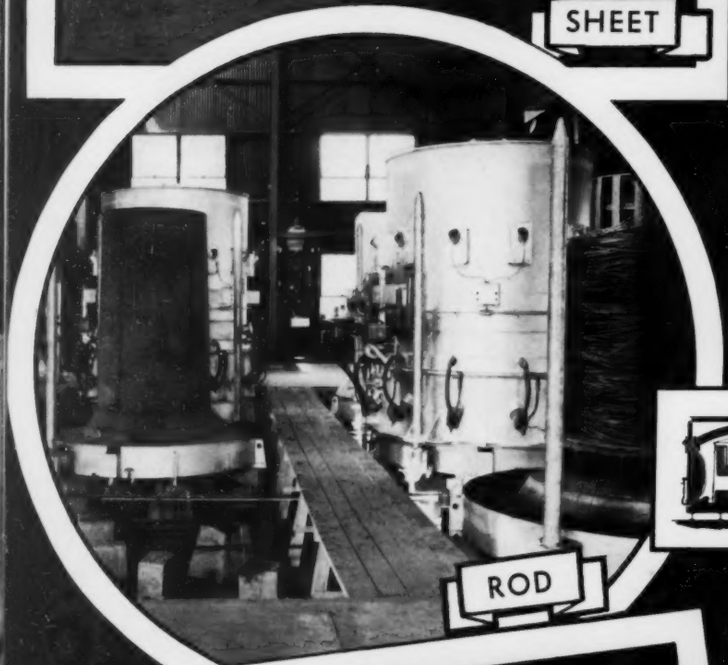
Wean-Wilson Coil Annealing Units

Wean Automatic Tinning Equipment

SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT

WILSON ANNEALING *for Steel*





An Exclusive Development of

LEE WILSON ENGINEERING CO.

1370 Blount Street • Cleveland, Ohio

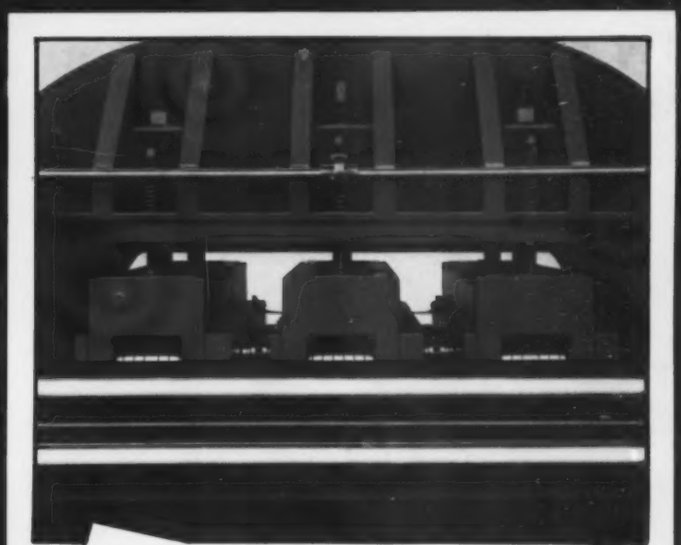
SOLD BY THE WEAN ENGINEERING CO., INC., WARREN, OHIO

SPECIALISTS IN ANNEALING EQUIPMENT
FOR ROLLED AND DRAWN STEEL PRODUCTS

McKAY

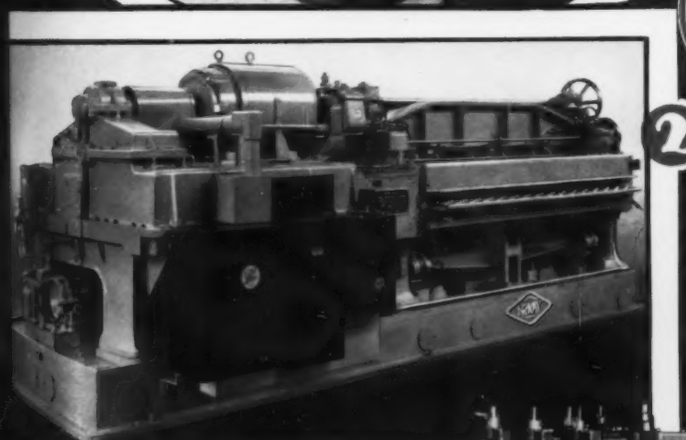
1. The McKay Processing Uncoiler.
2. The Budd-McKay Processing Machine.
3. McKay Backed-up Roller Leveller with driven Backed-up Rolls.
4. Backed-up Roller Leveller.

1



3

McKAY MEKROMETER ADJUSTMENT



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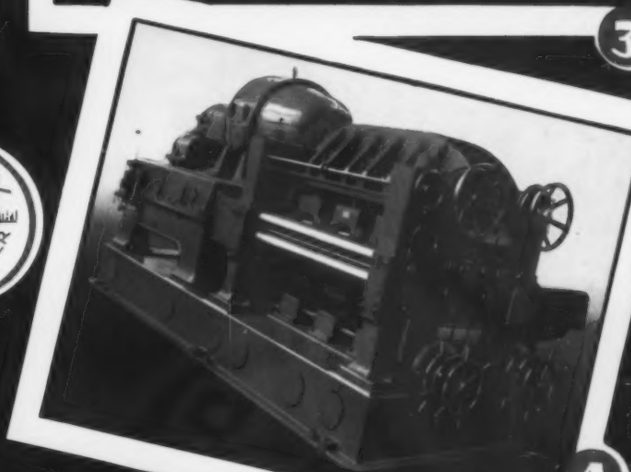


4

5. McKay Electric Tube Welder. 5

McKAY MACHINE Company

ENGINEERS AND MANUFACTURERS OF SHEET, TIN, AND STRIP MILL EQUIPMENT

YOUNGSTOWN, OHIO

ASSOCIATED COMPANY

The WEAN ENGINEERING CO., Inc. • WARREN, OHIO

FLINN & DREFFEIN CO.

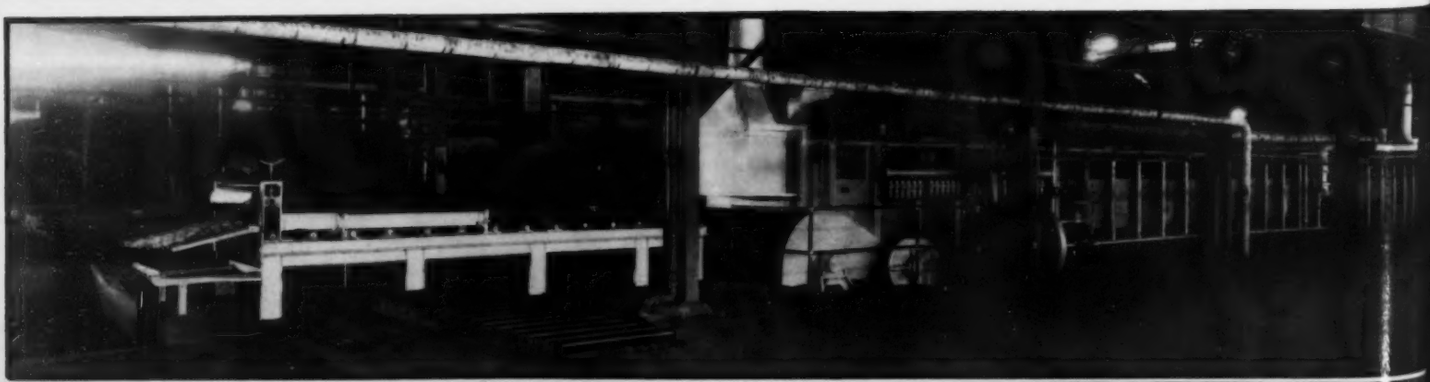
308 WEST WASHINGTON STREET
CHICAGO • ILLINOIS

Be Prepared for Preparedness

THE mighty bulwark of defense is steel. Flinn & Dreffein are designing and producing furnaces for ordnance work—for forging, nosing, and heat treating—also special furnaces for heat treating bombs.

Flinn & Dreffein furnaces will help the steel manufacturer to speed up his part in national defense.

31 YEARS IN FURNACE BUILDING



ASSOCIATED COMPANY • THE WEAN ENGINEERING CO., INC. • WARREN, O

Annealing Output Helped By Micromax Controllers

30 Rust Furnaces Controlled At Indiana Harbor

High-quality annealing of strip and sheets is accomplished at Youngstown's Indiana Harbor plant by means of Rust furnaces, with an ingenious control which employs Micromax pyrometers. Known as "Duotrol", this system is applied to about thirty furnaces in the plant.

Distinctive feature of the control is the use of a multipoint Micromax for each furnace, connected to one thermocouple in the furnace roof and to four embedded in the charge. The instrument records all 5 temperatures, but the control is based only on the roof couple and on the coldest one of the charge couples. The relationship of the two is biased to permit swiftest heating of the charge, without overheating of the furnace.

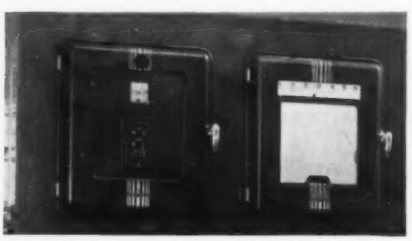
Such control is, of course, neither needed nor advisable for most furnaces, but it does demonstrate the responsiveness and dependability of the Micromax instrument. It shows the practical use of the Micromax "safety factor." The instrument which can handle this control can be relied on for production-assuring controls of every known type of furnace. And, usually, the control can be automatic. For details, ask for Catalogs N-33A and N-00A.

PressureControllerHelps Operate Big Furnaces

Additional help for today's busy heaters, melters, helpers and other operators of big furnaces is provided by this brand-new model of the time-tried L&N Furnace Pressure Controller.

It holds pressure wherever the user wants it; responds to changes as small as a thousandth of an inch of water. It is put to work by touching a button on its case; and another touch puts the furnace back on manual control, with the push-buttons on the Controller case. The degree of furnace pressure can be changed by turning a knob. . . . Space in narrow control aisles is saved because this Controller mounts flush in the control panel.

With all its external convenience features, the L&N Furnace Pressure Controller uses, inside, the simple, sensitive machine it has always used. See Catalog N-01A-600.



Left; a midwestern steel mill uses this L&N Pressure Controller on an open-hearth furnace

DOES YOUR PLANT *Benefit* From Micromax Dependability Tests?

Before it is shipped, every strip-chart Micromax pyrometer goes on this rack for at least four solid days of operation. For 96 hours it undergoes a series of tests—tests probably harder than service in any user's plant—tests which could only be made by instrument men with special equipment for checking the foundations of dependable operation.

Each Micromax sub-assembly gets its own carefully-engineered work-out; the standardizer, the micro-responsive balancing assembly; the motor-drive, the recording mechanism, all are strenuously operated.

And then comes the overall test—the machine must make and record hundreds of measurements, so accurately that only high-precision laboratory instruments can check them. Any Micromax thus proves in advance that it will give you the benefits of accurate, dependable recording or control.

Catalogs On Request

Furnace-Pot Thermocouples with Adjustable Angles

The use of thermocouples in lead and cyanide pots and similar furnaces is simplified by the new adjustable-angle connector used in L&N couples.

The connection between hot and cold leg is no longer one-piece, with screwed-on cover, but is in two pieces, with ground-joint metal-to-metal faces. It locks together at any desired angle . . . user is not limited to right angle . . . hence couple can bend to conform to slope of pot. And, the heat-treater can put the couple's tip where he wants it, without having the device project over the working surface of the bath.

See our *new* Thermocouple Catalog, No. N-33A(6), for further details of this and all other L&N couples. Sent on request.

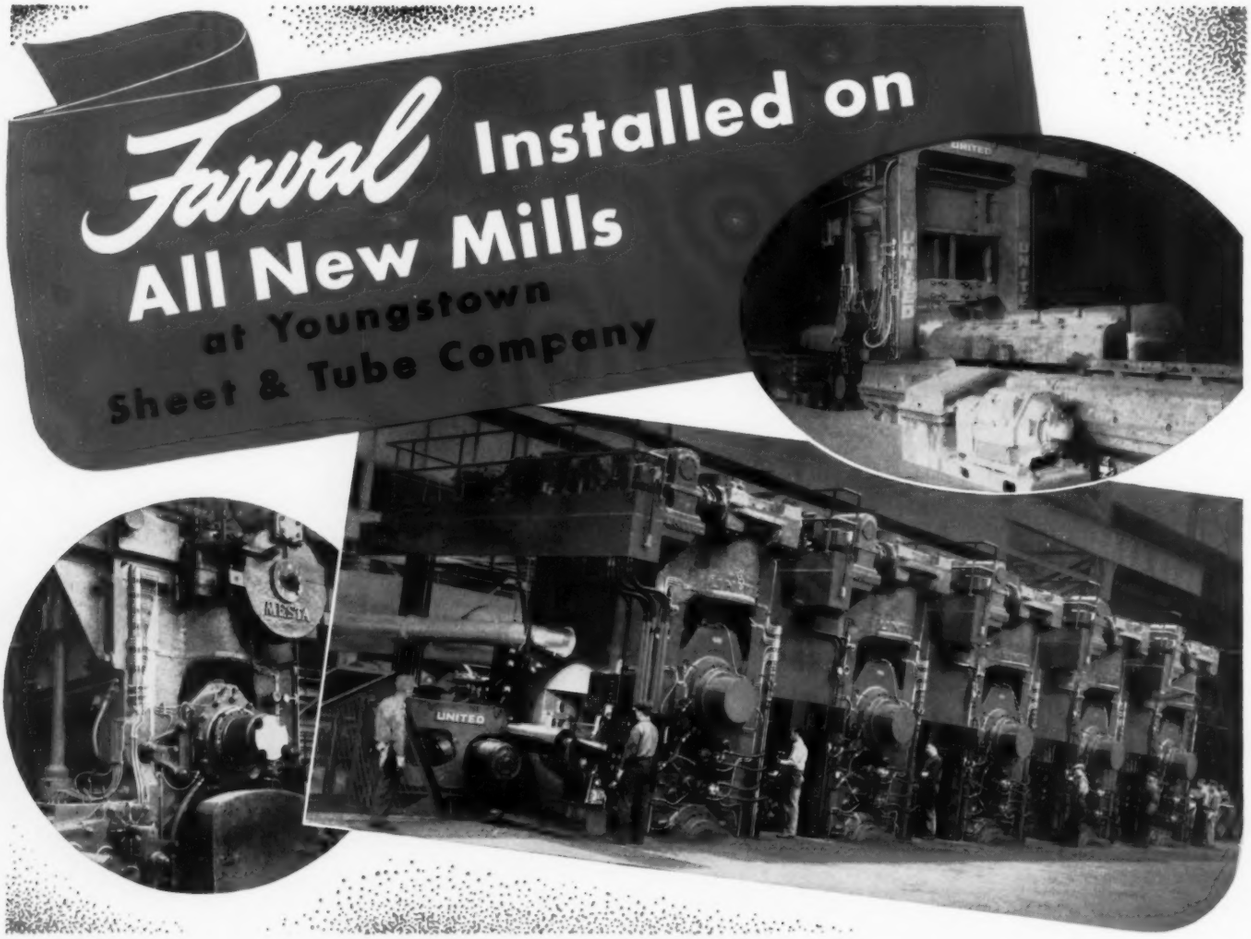
Jrl Ad N-0600C(5)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Farval Installed on All New Mills at Youngstown Sheet & Tube Company



With each expansion at Indiana Harbor to increase facilities for broader service to its customers, Youngstown Sheet & Tube has installed Farval to protect production schedules and insure continuous operation of all new equipment.

From the Tin Plate Mills in 1933 to the Continuous Butt Weld Pipe Mill in 1940, new mill equipment receives positive and dependable lubrication through Farval Centralized Systems.

In addition to the installations at Indiana Harbor, Farval is also serving the mills at Youngstown, including the Hot and Cold Strip Mills, Blooming Mill, Seamless Tube Mills and Continuous Butt Weld Pipe Mill. With the Levellers, Shears, Continuous Picklers and Pinch Rolls, more than 7500 bearings receive proper lubrication at regular intervals and not a bearing is missed.

Special Delivery TO EVERY BEARING

There are more Farval Systems installed on steel mill equipment than all other makes combined.

The Farval Corporation, 3278 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing

In Canada: PEACOCK BROTHERS LIMITED

FARVAL

CENTRALIZED SYSTEMS OF LUBRICATION

PROGRAM

36th ANNUAL CONVENTION and IRON AND STEEL EXPOSITION

ASSOCIATION OF IRON AND STEEL ENGINEERS

HOTEL STEVENS CHICAGO - ILLINOIS

SEPTEMBER 24 - 25 - 26 - 27, 1940

WISCONSIN STEEL COMPANY
190 North Michigan Avenue
CHICAGO

July 25, 1940

Association of Iron and Steel Engineers
Empire Building
Pittsburgh, Pennsylvania

Gentlemen:

My associates and I in the Wisconsin Steel Works are indeed happy to welcome the members of your Association as you return to the Chicago steel-making district for another of your annual conventions. I am happy also to couple this welcome with a most cordial invitation to your members to visit our Wisconsin Steel Works

Because of present world conditions, it seems very likely that this 36th Annual Convention of yours will be one of the most significant and important in your long and notable history. In the vital program now under way to strengthen our national security, the work of the iron and steel engineers is of the greatest basic importance.

Our nation, at a time like this, can be truly thankful for the great peace-time accomplishments in steel technology brought about by the co-ordinated efforts of the engineers of our industry--mechanical, electrical, metallurgical, hydraulic, lubricating and others. Your efforts, combined with those of the production men, have given this country steel products of the finest quality, at the lowest cost and in greater quantities than in any other country of the world. The measure of your accomplishments in the past is doubly reassuring when thought is given to what you may be asked to do in the future.

It is peculiarly appropriate that, with these thoughts in the minds of all of us, you should come again to the great Chicago steel district, astride the paths of commerce of our nation. Here is a great national asset, either in peace or in the building of the sinews that strengthen our national security.

May I wish for you, on behalf of all my colleagues of the Chicago steel area, a most successful convention, and a most profitable, interesting and pleasant visit to our mills and furnaces.

Sincerely yours,

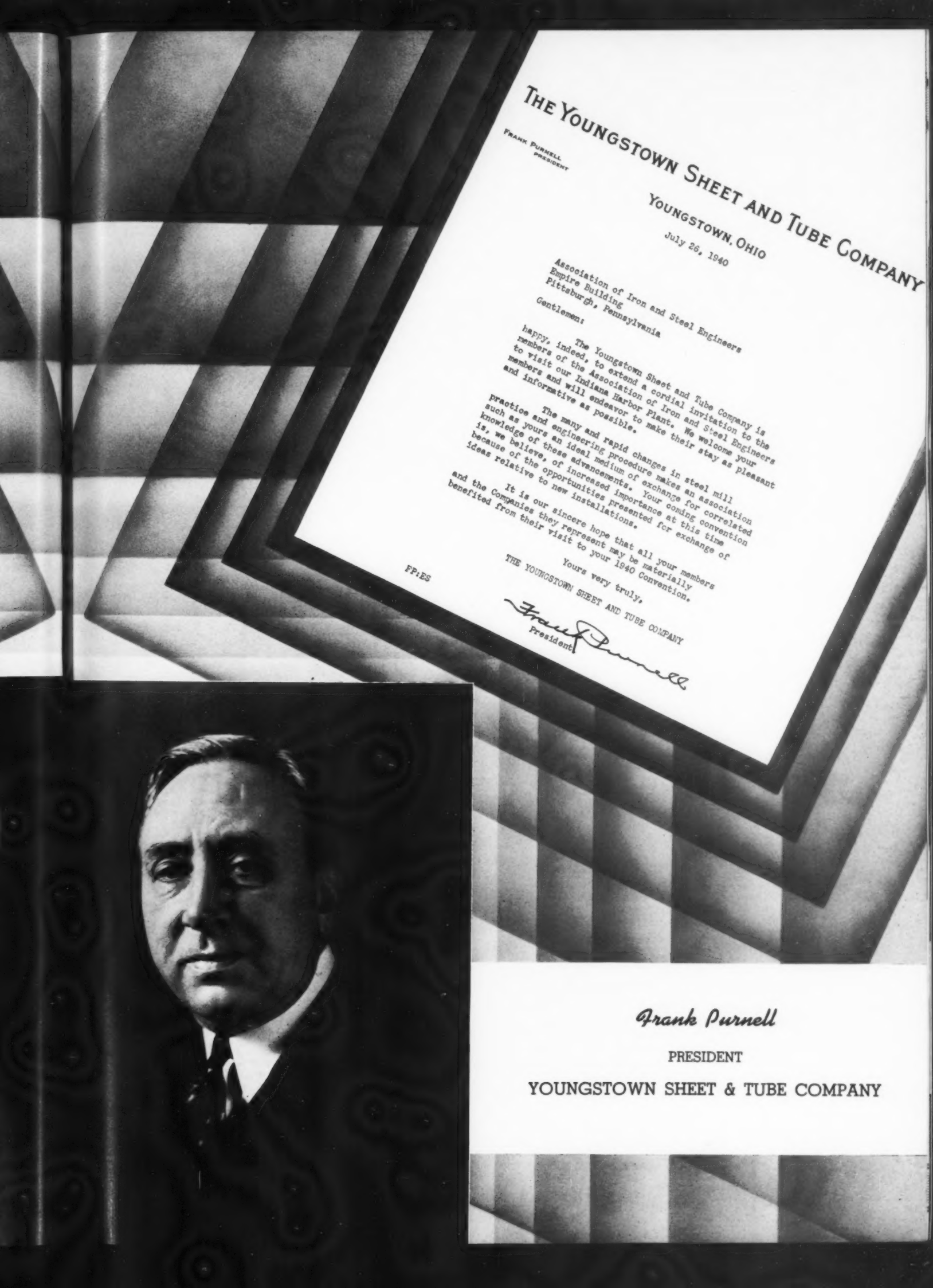
Geo. E. Rose

President

George E. Rose

PRESIDENT

WISCONSIN STEEL COMPANY



THE YOUNGSTOWN SHEET AND TUBE COMPANY

FRANK PURNELL
PRESIDENT

YOUNGSTOWN, OHIO

July 26, 1940

Association of Iron and Steel Engineers
Empire Building
Pittsburgh, Pennsylvania

Gentlemen:

The Youngstown Sheet and Tube Company is happy, indeed, to extend a cordial invitation to the members of the Association of Iron and Steel Engineers to visit our Indiana Harbor Plant. We welcome your members and will endeavor to make their stay as pleasant and informative as possible.

The many and rapid changes in steel mill practice and engineering procedure makes an association such as yours an ideal medium of exchange for correlated knowledge of these advancements. Your coming convention is, we believe, of increased importance at this time because of the opportunities presented for exchange of ideas relative to new installations.

It is our sincere hope that all your members and the Companies they represent may be materially benefited from their visit to your 1940 Convention.

Yours very truly,

THE YOUNGSTOWN SHEET AND TUBE COMPANY

President

FP:ES

Frank Purnell

PRESIDENT

YOUNGSTOWN SHEET & TUBE COMPANY

Edward L. Ryerson, Jr., chairman of the board, Inland Steel Company, has been associated with Inland since the acquisition of Joseph T. Ryerson and Son, Inc., in 1935. Mr. Ryerson has been with the Ryerson company since 1909, acting as president of that firm from 1929 to 1937, and has since been chairman of Ryerson in addition to his activities at Inland Steel Company.

Mr. Ryerson has been an outstanding leader in civic and philanthropic work in Chicago. He was for several years president of the Community Fund of Chicago and of the Council of Social Agencies. Mr. Ryerson is also a director of the Northern Trust Company, Quaker Oats Company, American Brake Shoe and Foundry Company, and New York Life Insurance Company. He is a fellow of the Yale Corporation, a trustee of the University of Chicago and a trustee of the Carnegie Endowment for International Peace. He was born in Chicago, December 3, 1886.

The 36th Annual Convention and Iron and Steel Exposition of the Association of Iron and Steel Engineers again presents to the personnel of the Iron and Steel Industry an opportunity to hear and view the modern trends and improvements in engineering and operating practices in the Industry.

With the Convention and Exposition coming at this period when production again assumes major significance, the opportunity of keeping abreast of new developments is particularly timely and I am pleased to extend on behalf of the Association a cordial greeting to the progressive engineers and operators in attendance.

JULIUS A. CLAUSS, *President*

ASSOCIATION OF IRON AND STEEL ENGINEERS

Inspection Trips

Indiana Harbor Works

Youngstown Sheet & Tube Co.

WEDNESDAY, SEPTEMBER 25

The Inspection Trip to the Indiana Harbor Works of the Youngstown Sheet and Tube Company, Wednesday afternoon, September 25, will originate at the Michigan Avenue entrance of the Stevens Hotel. The first bus will depart at 12:45 P.M.

The second Inspection Trip will be conducted to the Wisconsin Steel Works of the International Harvester Company, Friday morning, September 27, will also originate at the Michigan Avenue entrance of the Stevens Hotel. The first bus will leave at 9:00 A.M.

Officials of both companies have expressly requested that those participating in the above Inspection Trips use the special transportation facilities which will be provided by the Association of Iron and Steel Engineers; otherwise no one will be permitted to enter the plants.

Tickets for these Inspection Trips will be placed on sale at the Registration Desk in the Business Lobby, Main Floor, Stevens Hotel, the first day of the Convention. It is advised that those wishing to participate in the trips purchase tickets at the earliest opportunity, so that ample transportation facilities will be available.

Wisconsin Steel Works

International Harvester Company

FRIDAY, SEPTEMBER 27

Convention Committees

GENERAL CHAIRMAN OF CONVENTION AND EXPOSITION

Chairman
Julius A. Clauss
Chief Engineer
Great Lakes Steel Corporation
Ecorse, Michigan

Vice Chairman
H. R. Middlebrook
Power Superintendent
Carnegie-Illinois Steel Corporation
Gary, Indiana

GENERAL CONVENTION COMMITTEE

Chairman
W. A. Perry
Superintendent, Electrical and Power Departments
Inland Steel Company
East Chicago, Indiana

Vice Chairman
L. R. Milburn
Electrical Engineer
Great Lakes Steel Corporation
Ecorse, Michigan

REGISTRATION COMMITTEE

Chairman
L. F. Coffin
Mechanical Superintendent
Bethlehem Steel Company
Sparrows Point, Maryland

Vice Chairman
A. R. Dibben
Assistant Electrical Superintendent
Youngstown Sheet and Tube Company
East Chicago, Indiana

IRON AND STEEL EXPOSITION COMMITTEE

Chairman
C. C. Wales
Vice President
Hamilton Bridge Company, Ltd.
Hamilton, Ontario, Canada

Vice Chairman
Frank P. May
Assistant Chief Engineer
Carnegie-Illinois Steel Corporation
By-Product Coke Works
Clairton, Pennsylvania

COMMITTEE ON ATTENDANCE

Chairman
C. L. McGranahan
Assistant General Superintendent
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

Vice Chairman
R. L. Shoemaker
Lubrication Engineer
American Rolling Mill Company
Middletown, Ohio

FORMAL RECEPTION COMMITTE

Chairman
J. A. Clauss
Chief Engineer
Great Lakes Steel Corporation
Ecorse, Michigan

Vice Chairman
W. S. Hall
Chief Engineer, Chicago District
Carnegie-Illinois Steel Corporation
Chicago, Illinois

LOCAL CHICAGO DISTRICT SECTION ENTERTAINMENT COMMITTEE

General Chairman
H. R. Middlebrook
Power Superintendent
Carnegie-Illinois Steel Corporation
Gary, Indiana

Chairman, Entertainment
A. A. Piper
District Manager
Electric Controller and Manufacturing Company
Chicago, Illinois

Vice Chairman, Entertainment
R. O. Herbig
District Manager
Reliance Electric and Engineering Co.
Chicago, Illinois

V. S. Acton
Sales Engineer
Westinghouse Electric and Manufacturing Company
Chicago, Illinois

George B. Henry
Sales Engineer
General Electric Company
Chicago, Illinois

Frank J. Burd
Cutler-Hammer, Inc.
Chicago, Illinois

Tuesday, September 24

Iron and Steel Exposition—9:00 A.M.–10:00 P.M.
Exhibition Hall and Main Ball Room.

9:00 A.M.—REGISTRATION—Business Lobby, Main Floor.

Chairman:
L. F. COFFIN
Mechanical Superintendent
Bethlehem Steel Company
Sparrows Point, Maryland

Vice-Chairman:
A. R. DIBBEN
Asst. Electrical Superintendent
Youngstown Sheet and Tube Company
East Chicago, Indiana

9:00 A.M.—LADIES' REGISTRATION—Second Floor Lounge.

9:15 A.M.—BUSINESS SESSION—North Ball Room, Third Floor.

Chairman:
J. A. CLAUSS
Chief Engineer
Great Lakes Steel Corporation
Ecorse, Michigan

Vice-Chairman:
J. L. MILLER
Assistant Chief Combustion Engineer
Republic Steel Corporation
Cleveland, Ohio

9:30 A.M.—MECHANICAL ENGINEERING DIVISION—North Ball Room, Third Floor.

Chairman:
GEORGE H. ROSE
Chief Engineer
American Steel and Wire Company
Cleveland, Ohio

Vice-Chairman:
T. E. HUGHES
Maintenance Superintendent
Carnegie-Illinois Steel Corporation
Duquesne, Pennsylvania

"Design and Operation of Gear Drives" by F. P. Dahlstrom, *Mechanical Engineer,* Farrel-Birmingham Company, Ansonia, Connecticut.

"Maintenance Shops in the Steel Plant" by T. R. Moxley, *General Master Mechanic,* Wheeling Steel Corporation, Steubenville, Ohio.

"Diesel Shifting Equipment in the Steel Plant" by E. M. Smith, *Assistant Sales Manager,* Electromotive Corporation, LaGrange, Illinois.

1:30 P.M.—ELECTRICAL ENGINEERING DIVISION—North Ball Room, Third Floor.

Chairman:
I. N. TULL
Electrical Superintendent
Republic Steel Corporation
Cleveland, Ohio

Vice-Chairman:
H. W. NEBLETT
Development and New Design Engineer
Inland Steel Company
East Chicago, Indiana

"The Application of Demagnetizing and IR Drop Compensation to Cold Strip Mills" by G. E. Stoltz, *Manager,* Metal Working Engineering, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

"Modern Electric Furnace Design and Practice" by H. F. Walther, *Assistant Melting Superintendent,* Steel and Tube Division, Timken Roller Bearing Company, Canton, Ohio.

"Mercury Arc Rectifiers for Main Roll Drives" by L. A. Umansky, Mining and Steel Mill Section, Industrial Department, General Electric Company, Schenectady, New York.

1:30 P.M.—WELDING ENGINEERING DIVISION—South Ball Room, Third Floor.

Chairman:
L. J. GOULD
Assistant Chief Engineer of Construction
Bethlehem Steel Company
Bethlehem, Pennsylvania

Vice-Chairman:
A. W. STEED
Maintenance Superintendent
American Rolling Mill Company
Middletown, Ohio

"Welded Construction of Blast Furnace Stoves" by H. C. Boardman, Chicago Bridge and Iron Company, Chicago, Illinois.

"Welded Open Hearth Auxiliaries" by C. C. Keyser, *Welding Supervisor,* Bethlehem Steel Company, Steelton, Pennsylvania.

"Building Up and Hard Surfacing" by L. Ames, Air Reduction Sales Company, New York, New York.

1:30 P.M.—LADIES' SIGHT-SEEING TRIP AND TEA at South Shore Country Club. Meet at Ladies' Headquarters, Second Floor Lounge.

10:00 P.M.—EXHIBITORS' DANCE—Boulevard Room, Second Floor. Informal.

Wednesday, September 25

Iron and Steel Exposition—9:00 A.M.–10:00 P.M.
Exhibition Hall and Main Ball Room.

9:00 A.M.—COMBUSTION ENGINEERING DIVISION—South Ball Room, Third Floor.

Chairman:
H. T. WATTS
Combustion Engineer
Republic Steel Corporation
Gadsden, Alabama

Vice-Chairman:
E. J. WAGAR
Assistant Chief Engineer
Otis Steel Company
Cleveland, Ohio

"Effect of Pit Operation on Steel Conditioning" by Charles Labeka, Metallurgical Department, Pittsburgh Steel Company, Monessen, Pennsylvania.

"The Comparison of Soaking Pit Designs" by F. E. Leahy, *Superintendent of Fuel Department,* Youngstown Sheet and Tube Company, Youngstown, Ohio.

"Soaking Pit Control" by M. J. Boho, *Sales Engineer,* Hagan Corporation, Pittsburgh, Pennsylvania.

9:00 A.M.—OPERATING PRACTICE DIVISION—North Ball Room, Third Floor.

Chairman:
H. G. R. BENNETT, *Engineer*
Hot Rolling Mills
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

Vice-Chairman:
J. D. JONES
Chief Engineer
Youngstown Sheet and Tube Company
Youngstown, Ohio

"Composition Bearings for Roll Necks" by H. R. Gilchrist, *Lubrication Engineer,* Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

"Hot Scarfing of Billets, Blooms and Slabs" by E. A. Doyle, *Consulting Engineer,* Linde Air Products Company, New York, New York.

"Design and Operation of Continuous Butt Weld Pipe

Mills" by J. H. Loux, *Electrical Engineer,* and E. T. Trebilcock, *Assistant Electrical Engineer,* Salem Engineering Company, Salem, Ohio.

12:00 Noon—LADIES' LUNCHEON, STYLE SHOW, AND CARD PARTY—Wedgwood Room, Marshall Field's. Meet at Ladies' Headquarters, Second Floor Lounge. Transportation will be provided.

12:45 P.M.—INSPECTION TRIP: Youngstown Sheet and Tube Company, Indiana Harbor, Indiana. Buses will leave Michigan Avenue entrance, Stevens Hotel.

Thursday, September 26

Iron and Steel Exposition—9:00 A.M.–5:30 P.M.
Exhibition Hall and Ball Room.

9:00 A.M.—ELECTRICAL ENGINEERING DIVISION—North Ball Room, Third Floor.

Chairman:
F. O. SCHNURE
Electrical Superintendent
Bethlehem Steel Company
Sparrows Point, Maryland

Vice-Chairman:
G. R. CARROLL
Assistant Superintendent of Maintenance
Jones and Laughlin Steel Corporation
Aliquippa, Pennsylvania

"Reversing Drives for Slabbing Mills" by F. R. Burt, Engineering Department, Metal Working Section, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

"Power Requirements for Hot Strip Mills" by W. M. Ballenger, *Steel Mill Engineer,* General Electric Company, Chicago District, and T. R. Rhea, *Steel Mill Engineer,* General Electric Company, Schenectady, New York.

"Hot Strip Coilers and Their Drives" by R. A. Geuder, *Application Engineer,* Reliance Electric and Engineering Company, Cleveland, Ohio.

9:00 A.M.—COMBUSTION ENGINEERING DIVISION—South Ball Room, Third Floor.

Chairman:
M. J. CONWAY
Special Engineer
Lukens Steel Company
Coatesville, Pennsylvania

Vice-Chairman:
G. M. COUGHLIN
Combustion Engineer
American Rolling Mill Company
Ashland, Kentucky

"A Survey of Open Hearth Furnace Design" by W. C. Buell, Jr., *Consulting Engineer,* Cleveland, Ohio.

"Relation of Flame Characteristics to Open Hearth Operation" by A. J. Fisher, *Fuel Engineer,* Bethlehem Steel Company, Sparrows Point, Maryland.

"Open Hearth Furnace Control" by M. J. Bradley, *Engineer,* Leeds and Northrup Company, Philadelphia, Pennsylvania.

1:30 P.M.—OPERATING PRACTICE DIVISION—North Ball Room, Third Floor.

Chairman:
ALBERT W. VINCENT
Assistant Superintendent of Blast Furnaces
Carnegie-Illinois Steel Corporation
Gary, Indiana

Vice-Chairman:
C. P. BETZ
Assistant Manager, Hanna Furnace Division
Great Lakes Steel Corporation
Ecorse, Michigan

"Developments in Blast Furnace Gas Cleaning" by C. H. Glaser, *Superintendent* of Blast Furnaces, Carnegie-Illinois Steel Corporation, Youngstown, Ohio.

"Rehabilitation of Blast Furnaces" by J. H. Slater, *Assistant District Manager,* Republic Steel Corporation, Cleveland, Ohio.

"Factors Affecting Production of Blast Furnace Gas" by J. S. Fulton, *Special Representative,* Ingersoll-Rand Co., Pittsburgh, Pennsylvania.

1:30 P.M.—LUBRICATION ENGINEERING DIVISION—South Ball Room, Third Floor.

Chairman:
F. J. THOMAS
Lubrication Engineer
Republic Steel Corporation
Cleveland, Ohio

Vice-Chairman:
H. H. SHAKELY
General Master Mechanic
Jones and Laughlin Steel Corporation
Hot and Cold Strip Mills
Pittsburgh, Pennsylvania

"Manufacture and Composition of Grease Lubricants" by Thomas Lennox, Socony-Vacuum Oil Corporation, Trenton, Michigan.

"Lubrication and Its Relation to Maintenance" by C. W. Phillips, *General Master Mechanic,* and R. A. Barta, *Lubrication Engineer,* Republic Steel Corporation, Cleveland, Ohio.

"Application and Care of Bearings in Steel Plant Auxiliaries" by F. L. Gray, *Lubrication Engineer,* Carnegie-Illinois Steel Corporation, Gary Works, Gary, Indiana.

7:30 P.M.—FORMAL BANQUET AND DANCE—Boulevard Room, Second Floor.
Speakers: E. L. Ryerson, Jr., *Chairman of Board,* Inland Steel Company, Chicago, Illinois; and Capt. A. A. Nichoson, *Personnel Director,* Texas Company, New York, New York.

Friday, September 27

Iron and Steel Exposition—9:00 A.M.–12:00 Noon
Exhibition Hall and Main Ball Room.

9:00 A.M.—INSPECTION TRIP: Wisconsin Steel Works, International Harvester Company, Chicago, Illinois. Buses will leave Michigan Avenue entrance, Stevens Hotel.

All Activities under One Roof

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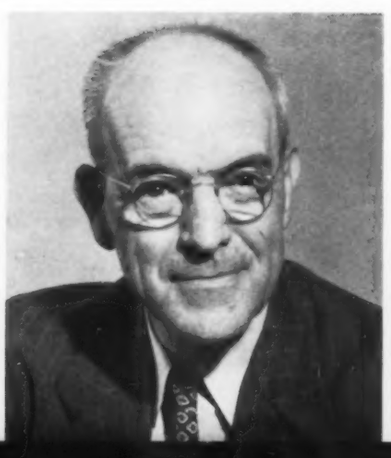

...Don't Fail to Visit the

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Iron & Steel Exposition

SPONSORED BY

ASSOCIATION OF IRON AND STEEL ENGINEERS

HOTEL STEVENS CHICAGO - ILLINOIS

SEPTEMBER 24 - 25 - 26 - 27, 1940

PRESENTING the latest developments in the products of over 100 manufacturers of steel plant equipment, the annual Iron and Steel Exposition, held in conjunction with the annual Convention of the Association of Iron and Steel Engineers, offers much of interest to engineering and operating men of the iron and steel industry.

Utilizing 30,000 sq. ft. of space, the exhibits offer a complete cross-section of the engineering applications in the industry and will prove of universal appeal to those who desire to keep abreast of the new improvements. The Exposition will be held in the Hotel Stevens, in close proximity to the technical sessions and other activities of the Convention. This placing of all activities under one roof facilitates complete participation in all Convention activities.

EXPOSITION HOURS

TUESDAY, SEPT. 24—9:00 A. M. to 10:00 P. M.
WEDNESDAY, SEPT. 25—9:00 A. M. to 10:00 P. M.
THURSDAY, SEPT. 26—9:00 A. M. to 5:30 P. M.
FRIDAY, SEPT. 27—9:00 A. M. to 12:00 Noon.

View of Exposition in Chicago, 1937

Wisconsin Steel Company

Wisconsin Steel Company

By T. J. ESS *with personnel photographs by* J. R. SCOTT

▲SPRINGING from the oldest steel company in the Chicago district, the Joseph H. Brown Iron and Steel Company, founded in 1875, the present compact, integrated Wisconsin Steel Works of the International Harvester Company presents an excellent example of the great strides and constant development of the steel industry in the United States. Since becoming a part of the International Harvester Company in 1902, this plant has been expanded to meet broadening requirements. At present, Wisconsin Steel Works occupies a site on the Calumet River of about 200 acres, upon which are three batteries of coke ovens, three blast furnaces, nine open hearth furnaces, bloom and billet mills, four merchant bar mills, and a cold drawn bar department. Its products include coke; basic, bessemer, foundry and malleable pig iron; ingot; blooms; billets; slabs; structural shapes; merchant bars; universal plate; hot rolled strip; wire rods; cold drawn and turned shafting. Annual capacities are approximately as follows:

Coke plant	600,000 tons coke
	3,300,000 gal. light oil
	9,500,000 gal. tar
	10,000 ton ammonium sulphate
Blast furnaces	642,600 tons pig iron
Open hearth	650,000 tons basic steel ingots
Bloom and billet mills	730,000 gross tons
Merchant mills:	
Structural shapes, heavy	15,000 gross tons
Universal plates	40,000 gross tons
Strip	80,000 gross tons
Merchant bars	325,000 gross tons
Wire rods	5,000 gross tons
All other	15,000 gross tons
Total	480,000 gross tons
Cold drawn bars	30,000 gross tons

About one half of the plant product is used in the various manufacturing activities of the company, the balance being sold to outside consumers.

COKE PLANT AND BLAST FURNACES

Coal for coking is obtained from the 6500 acre company owned field in Benham, Harlan County, Kentucky, which has a yearly capacity of 900,000 tons. This coal averages 37.1 per cent volatile matter, 58.5 per cent fixed carbon, and 4.4 per cent ash. Sulphur runs about .63 per cent, and moisture, 3.2 per cent. Approximately 10 per cent of low volatile Pocahontas coal is used in the coal mix.

The coal is received by rail and by boat. Rail shipments may be unloaded either directly into track hoppers for immediate use or from a trestle into the storage dock. Boat shipments are unloaded by a coal unloader, of 500 tons per hr. capacity, to the storage dock or to hoppers for immediate use. The storage dock is 154 ft. wide x 900 ft. long, and parallels a boat slip 174 ft. wide. By the conventional system of conveyors, the coal is handled through a coal breaker, service bins, mixing bins, hammer mills, transfer tower, and into a 2000 ton charging bin, which serves all three oven batteries. Crushed to a fineness of 80–85 per cent through a $\frac{1}{8}$ in.

GEORGE E. ROSE
President

screen, the coal is charged into the ovens by a four-hopper larry car.

Two batteries, of 44 ovens each, are fired with coke oven gas. These ovens are 15 and 17 in. wide x 10 ft. 8⅜ in. high x 37 ft. long, and take charges of 11.1 tons of coal. The third battery is composed of 45 ovens, 15 and 17 in. wide x 12 ft. 6 in. high x 37 ft. 7 in. long, holding 13.3 tons of coal per charge. This battery is fired with an enriched blast furnace gas of about 105 Btu. per cu. ft. The ovens total a capacity of 1650 tons of furnace coke per day, with a coking time averaging about 15 hours. Yields show 66 per cent furnace coke, 1.4 per cent domestic coke, and 4.6 per cent breeze.

By-products are recovered in the conventional manner, and average about as follows:

Gas yield	10,870 cu. ft. per ton of coal
Tar	10.6 gal. per ton of coal
Ammonium sulphate	25.5 lb. per ton of coal
Light oil	4.25 gal. per ton of coal

Due to the rather high volatile content of the coal, the gas produced is of the order of 582 Btu. per cu. ft., with a sulphur content of about 270 grains per 100 cu. ft. The ovens burning coke oven gas consume about 37 per cent of their own gas make, while enrichment of blast furnace gas for the third battery uses about 5 per cent of its respective gas make. Approximately 10 per cent of the total gas make is sold to utility companies in the district, while the remaining surplus is piped to the open hearth, soaking pits, and merchant mills.

Iron ore is obtained principally from three company-owned mines in Minnesota: Agnew mine at Hibbing, Hawkins mine at Nashwauk, and Sargent mine at Keewatin. Two large company-owned ore boats transport the ore to the plant, where it is unloaded at a boat slip by three unloaders with a total capacity of 1000 tons per hour. Storage capacity for about 650,000 tons of ore and 90,000 tons of limestone is afforded by a storage yard about 1265 ft. long x 275 ft. wide, paralleling the slip and served by two 8 ton bridges.

From the high line bins, coke, in dropping directly into the skip cars, passes over a stationary screen. Ore and limestone bin gates are operated by a motor mounted upon the scale car. The electrically operated skip is interlocked with the revolving furnace top so as to insure definite charging sequence.

The three blast furnaces, which are located on a common center-line, are comparable in capacity, differing but slightly in lines, as shown in Table I. Foundations are established on piling, and about 10 ft. of bottom blocks separate the hearth from the concrete foundation. Eight cast iron columns support each furnace,

The three blast furnaces produce iron in a wide range of specifications, including basic and all grades of merchant iron.

while the twelve tuyeres are fed from a bustle pipe of 3 ft. inside diameter. Furnace lining is 31½ in. thick through the hearth and bosh of all furnaces, where cooling plates are installed, twelve rows in No. 1 and 2 furnaces and eleven rows in No. 3 furnace. Inwall lining is 54 in. thick, and in No. 3 furnace vertical cooling pipes are installed, extending upward for a distance of about 17 ft. above the bosh. At the stockline, twelve staggered rows of wearing plates, anchored in slag concrete placed between inside and outside brickwork, afford protection against abrasion for a height of 8 ft. 8½ in. A packing, 1½–2½ in. thick, is used between furnace shell and brickwork.

Blast, averaging 40,000–45,000 cu. ft. per min. per furnace, is supplied from three turbo-blowers, each of 60,000 cu. ft. per min. capacity at 30 lb. pressure, operating on 400 lb. steam pressure. Four vertical blowing engines furnish stand-by protection. No. 1 furnace is equipped with four 100 ft. x 22 ft. stoves, and No. 2 furnace with four 90 ft. x 22 ft. stoves. No. 3 furnace has three 115 ft. x 22 ft. stoves, two of which are composed of a patented checker construction with inserts. Blast temperatures of 1200 degrees F. are carried on No. 1 and 2 furnaces, and 1400 degrees F. on No. 3 furnace. Blast pressures average between 15 and 17 lb., and top pressures, 30 to 35 in. of water.

Gas is cleaned by passing through a dust catcher, a vortex cleaner and a tower washer on each furnace. In addition, gas disintegrators are provided on No. 2 and 3 furnaces. Gas from the latter equipment, representing about 30 per cent of the total under full operating conditions, is cleaned down to less than .01 grain solid content per cu. ft., and is used in the open hearth, soaking pits, one battery of coke ovens, and one set of blast furnace stoves. A 5 ft. line carries this gas to the open hearth and coke plant, where a dry type holder, of 1,500,000 cu. ft. capacity, maintains a constant pressure of 8 in. of water.

Iron is produced for plant use in a basic specification ranging 1.50–2.00 per cent manganese, .80–1.10 per cent silicon, .25 per cent phosphorus. All grades of merchant iron are also produced running 1.–5. per cent silicon, .40–2.50 per cent manganese, and up to .70 per cent phosphorus. With full operations, about 40 per cent of the production is basic iron and the balance merchant grades. About 90 per cent of the basic iron is used as hot metal in the open hearth, while the remainder of the basic and all of the merchant grades are put over two double-strand pig machines. This division of product requires one furnace to be operated on basic practice, one on merchant practice, while the third must be switched back and forth, calling for careful planning and skillful handling.

L. B. ROBERTSON
General Superintendent

On basic production, the furnaces average about 725 tons of iron per day, with a coke consumption of 1600 lb. and a stone consumption of 600 lb. per ton of iron. About 8 per cent of open hearth slag is also charged, and a slag volume of 1000–1100 lb. per ton of iron is produced. Top temperatures run between 200 and 300 degrees F. When producing merchant iron, these values vary widely with the grade of iron, showing 1600–1850 lb. of coke per ton of iron, 600–800 lb. of stone per ton of iron, 700–1000 lb. slag volume, and 300–550 degrees F. top temperature.

OPEN HEARTH

The open hearth building, composed of three parallel adjacent bays, totals approximately 185 ft. in width x 480 ft. long. The charging bay is served by two 7½

The open hearth furnaces burn mixed coke oven and blast furnace gas through a movable port.

TABLE I

Blast Furnace Lines

	No. 1 and 2 furnace	No. 3 furnace
Hearth diameter	18′ – 0″	18′ – 6″
Bosh diameter	21′ – 6″	21′ – 10″
Stockline diameter	16′ – 6″	16′ – 6″
Large bell diameter	12′ – 6″	12′ – 6″
Height of crucible	11′ – 11¼″	11′ – 11¼″
Height of bosh	11′ – 0¼″	10′ – 0″
Height of straight section	5′ – 4½″	9′ – 0″
Height of inwall section	46′ – 6″	44′ – 10″
Height of stock line section	15′ – 8″	16′ – 2¾″
Height of hearth to top platform	90′ – 6″	92′ – 0″
Height of hearth to iron notch	2′ – 0″	2′ – 0″
Height of hearth to cinder notch	6′ – 8″	6′ – 8″
Height of hearth to tuyeres	10′ – 0″	10′ – 0″
Working volume, tuyere line to 12 ft. below platform, cu. ft.	19,873	20,500
Diameter, inside of shell at bottom	30′ – 6″	32′ – 0″
Diameter, inside of shell at top	25′ – 0″	25′ – 0″
Bosh angle	80° – 59′	80° – 32′
Inwall slope in 12 in.	.656″	.713″
Number of tuyeres	12	12
Number of supporting columns	8	8

ton charging machines, and two 100 ton hot metal cranes with 40 and 15 ton auxiliary hoists. In the pouring bay there are two 175 ton ladle cranes, also equipped with 40 and 15 ton auxiliary hoists. Here in this building are located nine 100 ton basic open hearth furnaces, spaced on 84 ft. centers, and a 250 ton hot metal mixer. The furnaces measure 70 ft. overall length, and are 44 ft. long between the knuckles x 16 ft. wide inside of the brickwork at the foreplate line. They are equipped with sloping backwalls and sprung arch roofs 13½ in. thick, with 18 in. ribs. These thicknesses are increased by 4½ in. for a space about 6 ft. wide along the back wall.

One of the furnaces is equipped for combination firing with coke oven gas and fuel oil, and eight furnaces are equipped with movable ports which extend into the furnace on the burning end, but are withdrawn on the exhaust end of the furnace by means of an air cylinder. These latter furnaces burn a mixed-gas, composed of about two parts blast furnace gas and one part coke oven gas, giving a calorific value of about 260 Btu. per cu. ft.

Automatic control of fuel-air ratio and furnace pressure is provided on some of the open hearth furnaces.

Regenerator chambers are 7 ft. 10 in. wide for gas and 9 ft. 4½ in. wide for air x 38 ft. long x 25 ft. 9 in. high. The eight mixed gas furnaces are provided with vertical down-flow two-pass checkers. The pass nearest the furnaces contains checkerwork 7 ft. 10 in. and 9 ft. 4½ in. wide x 17 ft. 2¼ in. long x 13 ft. 3¼ in. high. A 2 ft. 9 in. idle pass leads to the second pass, which contains checkerwork of 7 ft. 10 in. and 9 ft. 4½ in. wide x 15 ft. 2 in. long x 14 ft. 7½ in. high. Checkers are constructed of 4½ in. x 3 in. x 9 and 12 in. brick, giving flues 6 in. x 9 in. in cross-section. The one combination furnace is constructed with single pass checkers.

The furnaces are completely insulated up to the charging floor level, and fans for air pressure for combustion are provided on eight furnaces. Automatic fuel-air ratio control is installed on the six furnaces operating on mixed-gas, and furnace pressure control is afforded on five furnaces.

Although nominally rated at 100 tons, the furnaces produce heats of 125 tons in a period of approximately 13 hours, tap to tap, giving a production rate of about 9.4 tons per furnace hour. The charge averages 40 per cent hot metal and 60 per cent scrap, with limestone running about 7 per cent of the metallic charge. Half of the scrap is derived from the plant and from the

W. E. BREWSTER
Assistant General Superintendent

J. H. DILLON
Chief Engineer

R. A. LINDGREN, *Superintendent of Blast Furnaces*, and B. A. STANDERLINE, *Superintendent of Coke Plant*

manufacturing operations of the Harvester company, while the remainder is purchased. Fuel consumption averages approximately 5,000,000 Btu. per ton for the shop, including all grades of steel, much of which is high grade alloy steel.

Steel is produced in a wide range of grades, from .08–1.00 per cent carbon. With full operation, production is composed of 5 per cent rimming steel, 25 per cent commercial steels, and 70 per cent forging and alloy steels. Steel is usually single poured into big-end-down ingots 20 in. x 20 in., 22 in. x 24 in., and 18 in. x 32 in., or into fluted big-end-up ingots of 21 in. or 26 in. diameter. The latter type, for killed steels, are used with hot tops of either the clay type or the permanent type. Before pouring, moulds are given a water dip and then sprayed with tar. This preparation is effected in a mould building 75 ft. wide x 460 ft. long, served by one 10 ton and one 15 ton cranes. Ladles of elliptical design are being adopted, with a double stopper rigging, allowing simultaneous pouring of two ingots. Some steel, such as silico-manganese grades, are poured through a nozzle of 3–3½ in. diameter into another ladle before pouring into ingot moulds, in order to obtain greater homogeneity and to prevent phosphorous reversion.

Open hearth heats of 125 tons are produced in 13 hours, and tapped into ladles of elliptical design.

The miscellaneous materials used in the open hearth process require a minimum of handling. A bin system, filled from hopper cars, makes the various refractory materials accessible for handling by the hot metal cranes. Another set of bins on the blast furnace high line delivers limestone and ore directly to the open hearth charging buggies. Furnace and ladle additions are stored in bins along the charging floor lean-to, from where they are moved over runways to the charging floor and subsequently handled by crane.

BLOOMING AND BILLET MILLS

After the ingots have stood long enough to solidify, they are moved to the stripper building, located near the soaking pits, where two 150 ton stripper cranes and an inverted stripper remove them from the moulds.

Six blocks of soaking pits, each of four holes, 8 ft. 3 in. long x 5 ft. 7½ in. wide x 8 ft. 6 in. deep to the brickwork, are installed. The pits are the conventional reversing regenerative type, burning a mixed blast furnace and coke oven gas of 180–210 Btu. per cu. ft. Fuel consumption averages about 1,100,000 Btu. per gross ton of ingots. Ingots are charged and drawn by two 5 ton pit cranes, and an ingot buggy transfers them to the blooming mill approach table.

The blooming mill is a two-high 40 in. reversing unit, equipped with rolls 40 in. in diameter x 92 in. long running in water-lubricated composition bearings. The rolls are designed with passes of 3, 4, 5, 6, 8 and 12 in. width, in addition to a bullhead pass. The mill is driven by a 7000 hp., 700 volt, 50–120 rpm. d-c. motor which receives power from a dual flywheel set consisting of two 3000 kw. 700 volt d-c. generators, operating in parallel and driven by a 4000 hp. 2200 volt, 352 rpm. induction motor. Mill auxiliaries are all electrically operated through magnetic control.

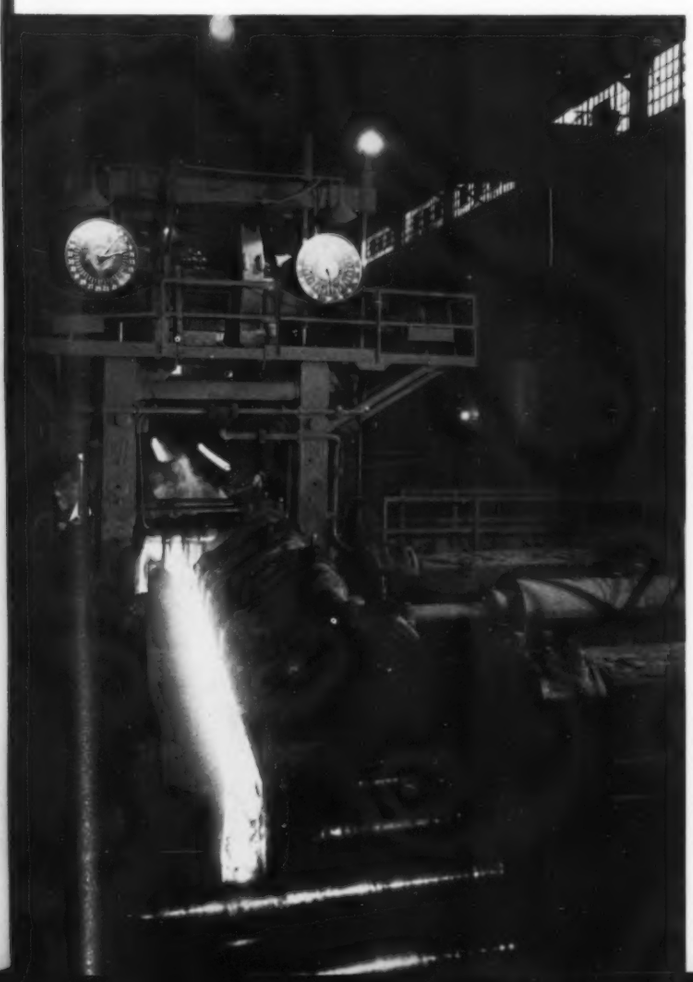
From the 40 in. mill, the mill table proceeds for a distance of about 470 ft. Approximately 100 ft. from the mill is an up-and-down-cut bloom shear having a capacity of 180 sq. in., driven by a 150 hp. 440 volt, 700 rpm. induction motor. Another bloom and slab shear, also of 180 sq. in. capacity, is placed about 250 ft. from the first shear. This unit is of down-cut type, with conventional crank and pitman design, and is driven through a motor operated clutch by a 200 hp. 440 volt, 702 rpm. induction motor. The motor operated screw type gauge for this shear is designed for gauging lengths from one to twenty feet. Both of these shears are provided with a skip buggy for discharging crops directly into railroad cars.

Following the second shear, billets may be pushed off on to a reciprocating dog-bar type conveyor which carries them to narrow gauge stake cars, or they may proceed to a sliding frame 54 in. hot saw, driven through belts by a 150 hp., 440 volt induction motor. The saw attains a peripheral speed of 23,000 ft. per min., and has a capacity to cut hot blooms up to 9 in. square.

Paralleling the blooming mill line at a distance of about 27 ft. is a second mill line, the first unit of which is a two-high 32 in. reversing blooming mill. This stand employs rolls 30 in. in diameter x 72 in. long, with passes of 3, 4, 5, 6 and 8 in. widths in addition to the bullhead. Roll necks are mounted in water-lubricated composition bearings. A 4000 hp., 700 volt, 75–165 rpm., d-c. motor drives this mill, and receives power from a dual flywheel set composed of two 2000 kw., 700 volt d-c. generators driven at 510 rpm. by a 3000 hp., 6600 volt induction motor. The motor operates through a universal type spring balanced lead spindle, a set of forged steel pinions, and universal mill spindles equipped with motor operated pull-backs. Pinions and pinion bearings are lubricated from an individual oiling system.

The mill is equipped with a double manipulator of rack type, motor operated. Front and back side guards are inter-connected by rack pinion line shafts, which are each driven through two herringbone speed reducers by 75 hp. motors. On both sides of the mill, lift fingers for turning the bloom are operated through a rack and planetary gear train by a 75 hp. motor. Mill screws are driven by two 100 hp. motors, and the

The 40 in. blooming mill generally serves as a primary break-down mill, feeding the 32 in. bloomer.



The 32 in. blooming mill, driven by a 4000 hp. reversing motor, breaks product from the 40 in. mill down to smaller sizes.

screwdown, with the exception of the screws themselves, is completely equipped with roller bearings.

Front and back mill tables are constructed with roller bearings, and are each driven through line shafts by two 75 hp. motors.

This mill line is connected to the line containing the 40 in. mill by two transfers. A 58 ft. one-way rail and cable transfer carries blooms from the table between the 40 in. mill and the first shear to the entrance side of the 32 in. mill. A 150 ft. two-way cable transfer connects the two mill lines at the exit side of the 32 in. mill.

Approximately 225 ft. from, and in line with, the 32 in. mill is a 21 in. continuous billet mill, at the entry to which is a swinging upcut crop shear, of 50 sq. in. capacity, driven by a 50 hp., 440 volt, 690 rpm. induction motor. The 21 in. mill consists of six roll stands and

E. L. RAMSEY
Superintendent of Steel Making

F. B. GOLLEY, *Superintendent of Blooming Mills,* and E. H. SCHWARTZ, *Superintendent of Open Hearth*

two vertical edging stands, each driven by individual motors. The entire train is operated under variable voltage control, receiving power from a motor-generator set composed of two 3500 hp., 600 volt, d-c. generators driven at 360 rpm. by a 9970 hp., 6600 volt synchronous motor. Speed regulation is controlled from the operating pulpit. Details of this mill are set forth in Table II.

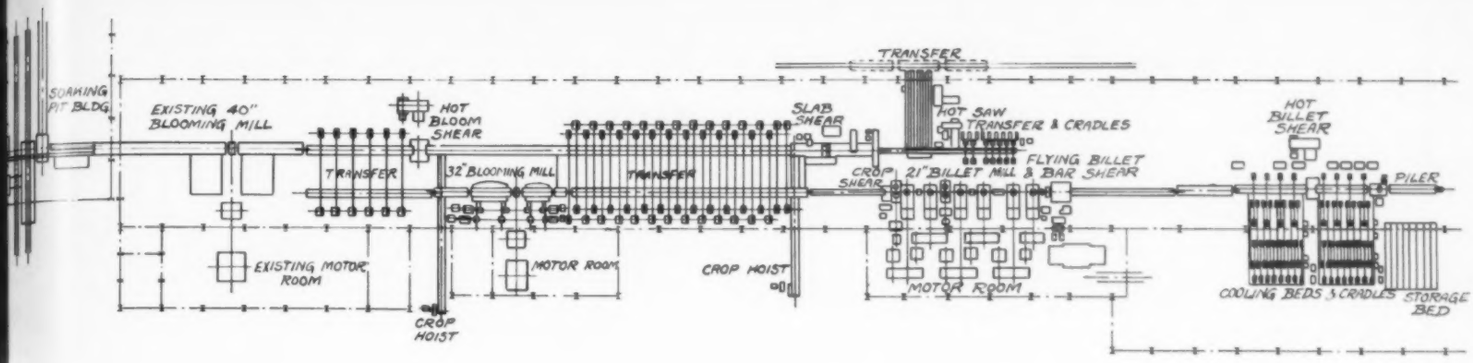
Separate stands have been provided for billets and wide flats. Billet stands are open housings, with top screws operated by spanner-wrenchs. Roller type twist guides are located between stands, and No. 1 edger is equipped with specially designed rolls for the purpose of turning the bloom into the diagonal position if desired. The wide bar stands have closed top housings, equipped with hand-wheel operated top screws. Top rolls are held against the screws by a spring hanger.

Between the stands are automatic roller loopers, actuated by torque motors. The mill stands are connected to their individual pinion stands through spring balanced spindles. Roll necks operate in composition bearings, water-lubricated.

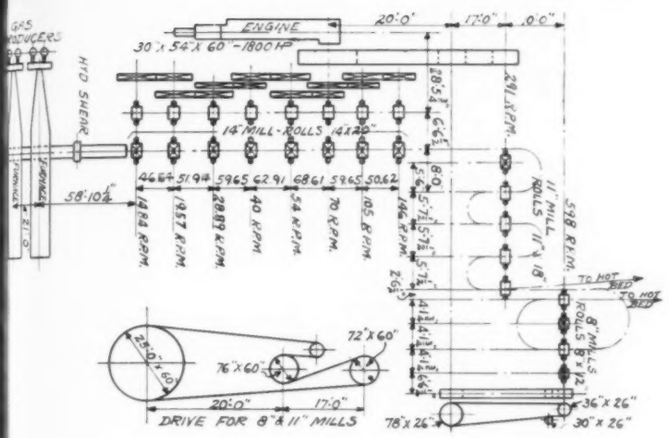
A hydraulic flushing and descaling system is installed, consisting of two 1500 gal. per min. centrifugal pumps, each driven by a 600 hp. induction motor. The use of one pump gives a pressure of 500 lb. per sq. in.. which may be boosted to 1000 lb. by using the second pump in series. The system is used for descaling in the billet mill, and for scale flushing on the blooming mill.

Located 16 ft. 10 in. beyond the last mill stand is a motor driven flying bar and billet shear, designed to cut billets up to 4 in. square and sheet bar up to $\frac{5}{8}$ in. x 24 in. in lengths of 12 to 36 ft. at speeds of 223–780 ft. per min. The shear is driven by two 150 hp. 600 volt, 465–1400 rpm. d-c. motors coupled to a common drive,

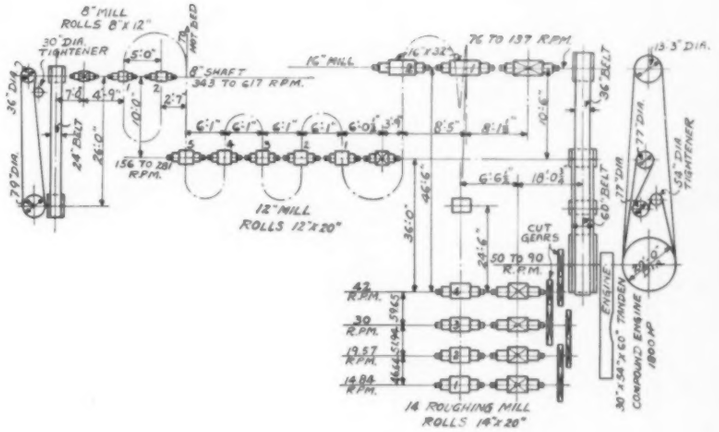
G. B. CONRAD, *Superintendent of Cold Draw Department,* and E. A. JENKINS, *Superintendent of Merchant Mills*



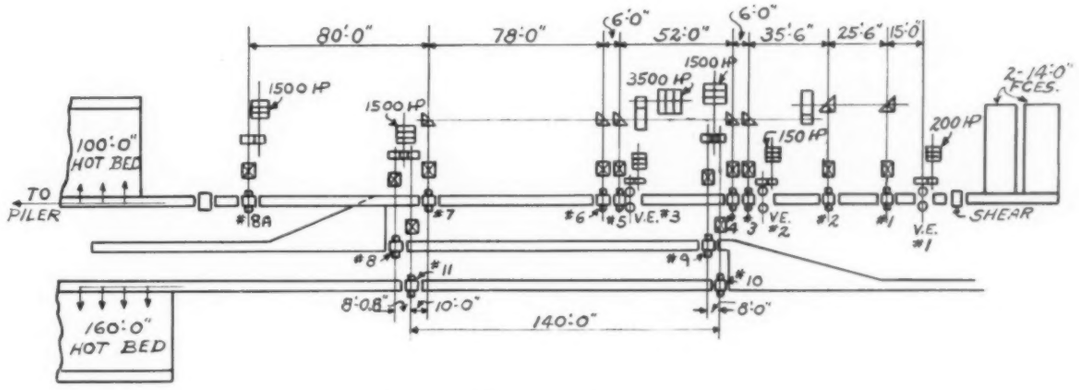
Layout of blooming and billet mills



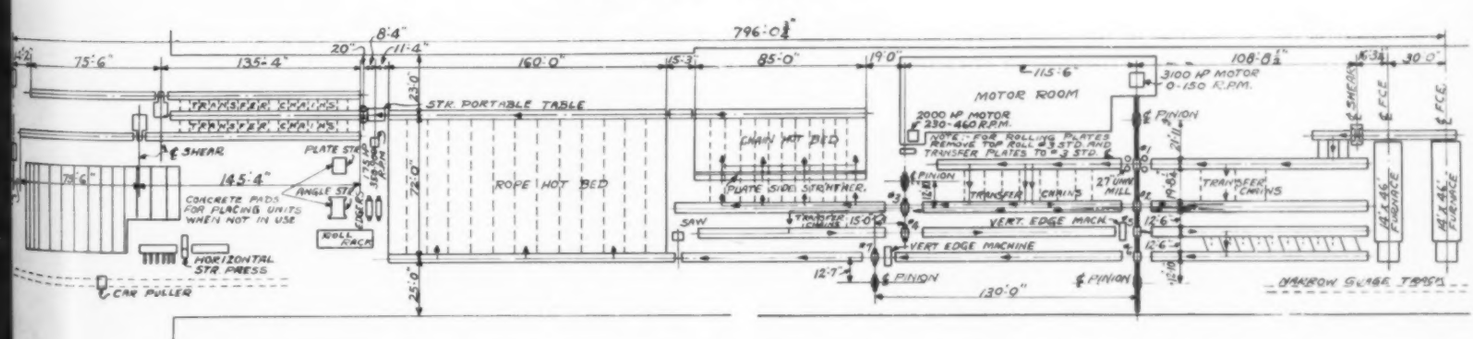
Layout of No. 1 merchant mill



Layout of No. 4 merchant mill



Layout of No. 2 merchant mill



Layout of No. 5 merchant mill

Wisconsin Steel Works

General Plan

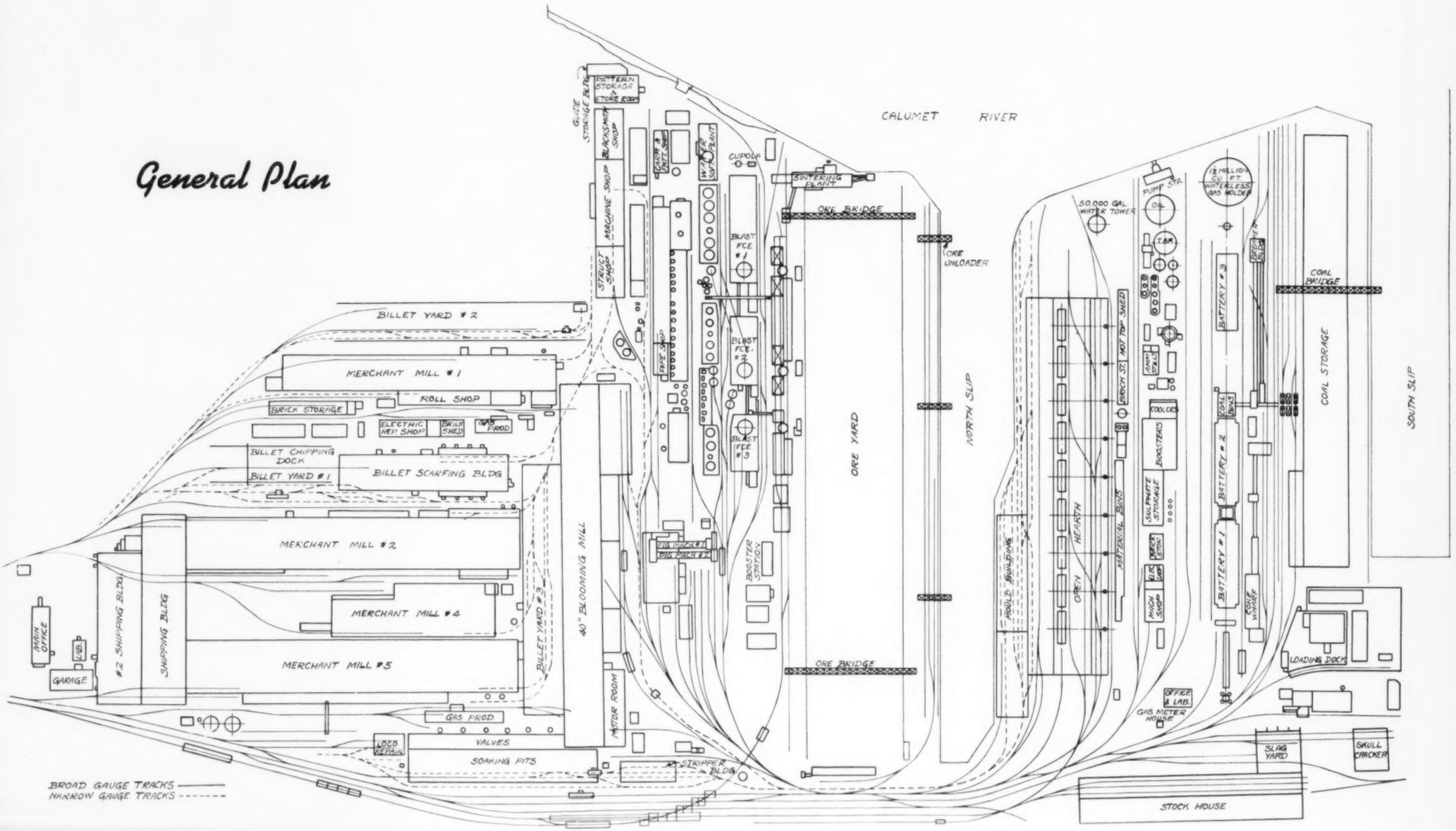


TABLE II
Data on 21 in. Billet Mill

Stand	Roll diameter	Roll body length		Distance from preceding stand	Motor data				Gear ratio	Roll rpm.
		Billets	Wide bar		Hp.	Voltage	Type	Rpm.		
No. 1 edger.....	18″	10″	10″	–	200	600	d-c.	300/900	27.27	11/33
No. 1 stand.....	21″	32″	24″	6′ – 7″	1500	600	d-c.	225/450	12.5	18/36
No. 2 stand.....	21″	32″	24″	14′ – 0″	1500	600	d-c.	300/600	12.5	24/48
No. 2 edger.....	18″	10″	10″	9′ – 0″	200	600	d-c.	300/900	13.63	22/66
No. 3 stand.....	21″	32″	24″	9′ – 0″	2000	600	d-c.	300/600	9.09	33/66
No. 4 stand.....	21″	32″	24″	14′ – 0″	2000	600	d-c.	300/600	6.97	43/86
No. 5 stand.....	21″	32″	24″	18′ – 0″	2000	600	d-c.	300/600	5.36	56/112
No. 6 stand.....	21″	32″	24″	12′ – 0″	2000	600	d-c.	300/600	4.29	70/140

and is synchronized with the mill by resistance control from the 600 volt bus. The cutting action of the knives is entirely vertical. Grooved knives are used when shearing billets, and straight knives when shearing flat bars.

From the flying shear, a run out table operates in a speed range of 283–1132 ft. per min., and carries the sheared stock to a skewed roller table 34 ft. long, which acts to properly align and bunch the material. From the skew table stock is moved to the delivery table to the cooling beds.

This table is divided into two sections, 42 ft. and 30 ft. long respectively. Between these sections is placed an up-and-down-cut billet shear with a capacity of 80 sq. in. of material, driven by a 150 hp., 440 volt 700 rpm. induction motor. The shear gauge gives a range of lengths from 6 to 16 ft. A piler is installed at the end of the table line. Two cooling beds, one on each side of the shear, 30 ft. wide x 60 ft. long, are also provided, over which billets may be moved to cradles.

It is apparent that the layout of blooming and billet mills offers a high degree of flexibility. Thus, material may proceed from the 40 in. mill straight through to shears or hot saw, or it may pass on through the 32 in. mill, or again, it may proceed directly to the 21 in. billet mill. Material from the 32 in. mill may proceed on through the billet mill, or it may be transferred to the 40 in. mill line and move on to shears or hot saw. In case the 40 in. mill is down, ingots may be taken directly to the 32 in. mill for blooming. Normally, however, the ingot is first broken down on the 40 in. mill. Slabs over 26 in. wide or blooms 10 in. x 10 in. or over are finished in this mill, while smaller sizes are passed on to 32 in. mill. Here sizes down to 3 in. x 4 in. or 3⅞ in. square are finished. The billet mill pro-

J. H. MILLER, *Superintendent of Electrical Department*, and G. D. BAILER, *General Master Mechanic*

F. M. WASHBURN, *Assistant Superintendent of Metallurgy and Inspection*, and B. F. COURTWRIGHT, *Superintendent of Metallurgy and Inspection*

duces squares ranging 1½ in. to 4 in. and flats ranging 12–24 in. wide and .310–1.0 in. thick.

Typical scheduling of some sizes through the three mill units is as follows:

40 in. mill	32 in. mill	21 in. mill
15 in. x 9½ in.	8 in. x 8 in.	
13 in. x 7½ in.	7 in. x 7 in.	
13 in. x 7½ in.	6 in. x 6 in.	
11 in. x 7½ in.	4 in. x 4 in.	
6 in. x 24 in.	2 in. x 24 in.	
15 in. x 9½ in.	15 in. x 4 in.	
9½ in. x 7½ in.	8 in. x 3 in.	
10 in. x 7½ in.	5 in. x 2½ in.	
7½ in. x 6¼ in.	5 in. x 5 in.	3⅞ in. x 3⅞ in.
7½ in. x 6¼ in.	4¾ in. x 4¾ in.	2½ in. x 2½ in.
7½ in. x 6¼ in.	4⅛ in. x 4⅛ in.	2¼ in. x 2¼ in. 2⅛ in. x 2⅛ in.
7½ in. x 6¼ in.	4⅛ in. x 4⅛ in.	1⅞ in. x 1⅞ in. to 1½ in. x 1½ in.
11½ in. x 7½ in.	5¾ in. x 5¾ in.	4 in. x 2 in.
6 in. x 18 in.	2 in. x 18 in.	3/16 in. x 18 in.

This entire mill unit operates at a rate averaging about 85 tons per mill hour, being limited somewhat by soaking pit capacity. A building 90 ft. wide x 800 ft. long houses the blooming and billet mills, and two cranes, of 50/10 tons and 15 tons respectively, are provided. The 32 in. and 21 in. mills were installed in 1937, in order to obtain increased capacity, and permitted the abandonment of an old steam driven 35 in. blooming mill built in 1903.

Paralleling and adjacent to the mill building is a billet yard containing a considerable number of steel boxes, lined with an insulating material. Material requiring slow cooling is covered by these boxes and allowed to remain until cool enough for further processing.

A system of transfers connects the two blooming mill lines, giving a convenient and flexible arrangement.

Bloom and billet conditioning is carried out by both manual chipping and manual scarfing, the latter process being used for about 80 per cent of the material conditioned. Scarfing is performed in a building, 80 ft. wide x 384 ft. long, which formerly housed an old steam driven blooming mill. Oxygen and carbo-hydrogen are both piped into the plant from near-by manufacturer's plants. Chipping is effected in a yard about 85 ft. wide x 285 ft. long, served by a 10 ton gantry crane. Two rows of chipping beds are laid out under the crane, and are each spanned by a number of small movable sheds which afford protection to the chippers, and which may be moved up and down the yard as desired on tracks provided for the purpose. Four wooden tanks, used for bar pickling, are located in one end of the chipping yard, and served by the gantry crane.

MERCHANT MILLS

Four merchant mills afford a wide range of re-rolled products, with a total capacity of 40,000 tons per month. Considering these in the order of their plant nomenclature, No. 1 mill consists of a continuous roughing train of eight stands, using rolls 14 in. in diameter x 20 in. body length running in babbitted bearings. Following this is a looping train of four 11 in. x 18 in. stands and another looping train of two 8 in. x 12 in., both using composition bearings on the roll necks. The continuous roughing train is grouped in a total space of about 33 ft., the stands being spaced approximately 4 to 5 ft. apart.

The entire mill is driven by a single 30 in. x 54 in. x 60 in. tandem compound steam engine rated at 1800 hp., 70 rpm. The continuous stands are driven through a train of gearing, and the looping trains are driven through belts and pulley wheels. Mill speeds attained through this arrangement are as follows:

No. 1 stand	14.84 rpm.
No. 2 stand	19.57 rpm.
No. 3 stand	28.89 rpm.
No. 4 stand	40. rpm.
No. 5 stand	54. rpm.
No. 6 stand	70. rpm.
No. 7 stand	105. rpm.
No. 8 stand	146. rpm.
No. 9, 10, 11 and 12 stands	291. rpm.
No. 13 and 14 stands	598. rpm.

Steel may be delivered to an inclined hot bed, 320 ft. long, either from No. 12 stand at a speed of 840 ft. per min., or from No. 14 stand at a speed of 1250 ft. per min. The mill produces rounds and squares ⅜ in. to 1¼ in., flats from ¾ in. x 3/16 in. to 2½ in. x ⅝ in., and ovals, half-ovals, half-rounds, and special angles of similar cross-section. Production averages 16–18 tons per mill hour.

Billets for No. 1 mill are heated in two continuous furnaces of 10 ft. 9 in. x 37 ft. hearth size, fired by producer gas from four producers. Waste gases leaving the furnaces are alternately passed through one of a pair of regenerative chambers, while air for combustion in the furnaces is heated by passing through the other re-generator. These gas flows are periodically alternated or "reversed," although the furnace itself has only uni-directional flow.

No. 1 mill is housed in a building 620 ft. long x 80 ft. wide, served by two 15 ton cranes. A roll shop is conveniently located adjacent to this mill building.

No. 2 mill is somewhat larger than No. 1 mill, and is of cross-country layout, and completely electrified. It is housed in a building 705 ft. long x 115 ft. wide, and is served by three 15 ton cranes and a billet charging crane. Two new triple-fired continuous heating furnaces, 59 ft. overall, with hearths 14 ft. wide x 52 ft. 6½ in. long, serve this mill. About 12 ft. of the hearth length is a solid soaking hearth. The furnaces may be fired with coke oven gas, producer gas, mixed gas or steam-atomized oil, as desired, each furnace having six combination burners in the main top zone, five burners in the bottom zone, and six burners in the soaking zone. Air for combustion is heated in refractory tile recuperators.

The mill is laid out in three parallel lines, the first of which contains four 18 in. x 32 in. stands, four 16 in. x 32 in. stands, and three 18¾ in. x 7½ in. vertical edgers. The edgers are located ahead of the first, third, and fifth, stands and are driven by 600 volt d-c. motors, one of 200 hp., 400–800 rpm., and two of 150 hp., 300–900 rpm. The first seven stands are driven through gearing by a 3500 hp., 600 volt, 175–350 rpm., d-c. motor. The next stand, No. 8a, is individually driven by a 1500 hp., 600 volt, 300–600 rpm., d-c. motor.

Steel may be delivered directly from No. 8a stand at a speed of 505–1010 ft. per min. through a flying shear and on to a piler or to a hot bed 100 ft. long; or, leaving No. 7 stand, the steel may be guided to a parallel mill line, which contains two 14 in. x 24 in. stands, and moved again to another parallel line which also contains two 14 in. x 24 in. stands. No. 8 and 11 stands are driven by a 1500 hp., 600 volt, 300–600 rpm. d-c. motor, and No. 9 and 10 stands are driven by a duplicate motor. Leaving No. 11 stand at speeds of 505–1010 ft. per min., material runs out upon a hot bed 160 ft. long.

Gearing is arranged so as to produce mill speeds as follows:

No. 1 edger	20.3–40.6 rpm.
No. 1 stand	15.8–31.6 rpm.
No. 2 stand	23.09–46.18 rpm.
No. 2 edger	32.3–96.9 rpm.
No. 3 stand	33.73–67.46 rpm.
No. 4 stand	45.1–90.2 rpm.
No. 3 edger	49.5–148.5 rpm.
No. 5 stand	60–120 rpm.
No. 6 stand	80.4–160.9 rpm.
No. 7 stand	98.3–196.6 rpm.
No. 8a stand	120.6–241.3 rpm.
No. 8 stand	120–240 rpm.
No. 9 stand	109.9–219.8 rpm.
No. 10 stand	125.1–250.3 rpm.
No. 11 stand	138–276 rpm.

Composition bearings, water-lubricated, are used on all roll necks of this mill. A descaling system duplicating that installed in the billet mill is provided for this mill.

The main roll drive motors on No. 2 mill receive power from a dual motor-generator set consisting of two 2500 kw., 600 volt, d-c. generators and one 7150 hp. 6600 volt, 514 rpm. synchronous motor. This mill was electrified in 1937, having been previously driven by a steam engine. Production averages about 26 tons per mill hour, and sizes range 1$^{3}/_{16}$–2 in. for rounds and squares; flats 1½–6 in. wide and ¼–1½ in. thick; bands 3$^{5}/_{16}$–14 in. wide; special and structural shapes of equal cross-sections.

No. 4 merchant mill is rather similar to No. 1 mill. It is served by a single continuous heating furnace of 10 ft. x 47 ft. hearth dimensions, fired with coke oven gas. Billets first pass through a continuous roughing train consisting of four 14 in. x 20 in. stands. Then follow three looping trains; the first of two 16 in. x 32 in. stands, the second of five 12 in. x 20 in. stands, and the third, two 8 in. x 12 in. stands. The entire mill is driven by a 30 in. x 54 in. x 60 in. tandem compound steam engine, rated at 1800 hp., 50–90 rpm. Gearing and pulley diameters are so arranged as to give the following mill speeds:

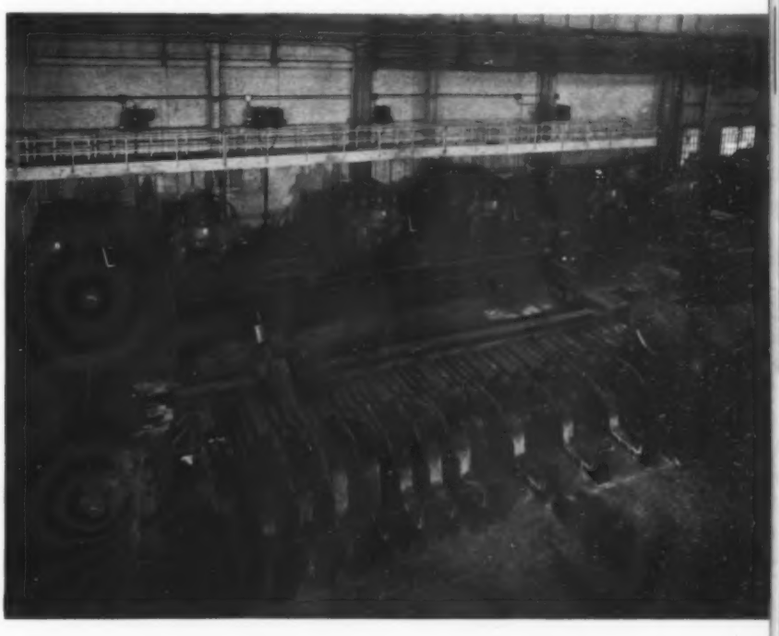
No. 1 stand	8.24–14.84 rpm.
No. 2 stand	10.87–19.57 rpm.
No. 3 stand	16.66–30 rpm.
No. 4 stand	23.33–42 rpm.
No. 5 and 6 stands	76–137 rpm.
No. 7, 8, 9, 10 and 11 stands	156–281 rpm.
No. 12 and 13 stands	343–617 rpm.

This mill delivers rounds and squares ¼–⅞ in., flats ranging ½–3½ in. wide and ⅛–$^{5}/_{16}$ in. thick, and small shapes and special sections. Production averages 10–11 tons per mill hour, and steel may be delivered either from No. 11 or No. 13 stands to a cooling bed 245 ft. long.

A building 370 ft. long x 87 ft. wide, served by one 15 ton crane, houses No. 4 mill, and a roll shop adjoins the mill building.

No. 5 mill, the heaviest merchant mill in the plant, was built in 1926 a completely electrified layout and is housed in a building 745 ft. long x 120 ft. wide, served by one 15 ton crane and one 60 ton crane. Two con-

View from pulpit of 21 in. billet mill, showing the mill in the background, with hot saw and cradle in foreground.



tinuous furnaces, with hearths 14 ft. x 45 ft., are top fired with steam-atomized oil, seven burners being spaced across the end wall of the furnace. Combustion air is preheated to a slight degree by passing over the top of the flat suspended furnace roof.

This mill is laid out in four parallel lines. In the first line is a 27 in. x 68 in. universal mill, which is driven directly from a 3100 hp., 700 volt, 70–150 rpm., d-c. motor. No. 2 stand, also 27 in. x 68 in., is driven directly by spindles from the universal mill. No. 3 and 4 stands, which are located side by side in parallel mill lines, are both 24 in. x 54 in. units, driven at 71.3–142.5 rpm. by a 2000 hp., 700 volt, 230–460 rpm., d-c. motors. No. 5 and 6 stands, also 24 in. x 54 in., are similarly located, and are driven at 84.6–169.1 rpm. by a duplicate motor. No. 7 stand, 24 in. x 48 in., is driven at 99.1–198.2 rpm. by a duplicate motor. Vertical edgers are placed ahead of No. 5 and No. 7 stands. Each is driven by a 175 hp., 230 volt 350–900 rpm. d-c. motor.

Main drive motors receive power from a flywheel motor-generator set made up of two 3000 kw., 700 volt d-c. generators driven at 356 rpm. by a 6500 hp., 2200 volt induction motor. One generator is connected only to the universal mill, while the other supplies the remaining drives in this mill.

Babbitted bearings are employed on the universal mill and on No. 2 stand, while the balance of the roll necks operate in water-lubricated composition bearings.

Transfers are located between the mill lines so as to afford a very flexible routing of material through the mill. Universal plate may be rolled in the universal mill alone, using up to eleven passes. It is then transferred to the next parallel line, run through No. 3 stand, from which the top roll is removed, and passed over a chain type hot bed to a conveyor table. Material may also be put through all stands of the mill in the order of their numbering, or it may pass directly from the furnaces to the No. 2 stand, and on through the balance of the mill. From No. 7 finishing stand, bars pass to a rope type hot bed 160 ft. long. A hot saw is located just ahead of the hot bed. The table receiving material from the hot beds leads through a straightening machine, which is driven by a 175 hp., 350–900 rpm., 230 volt d-c. motor. Two bar shears follow in parallel runs on either side of the straightener runout. The mill produces rounds and squares from 2 in. to 4½ in., flats ranging 4–8 in. in width and ¼–3 in. in thickness, and universal plate up to 30 in. wide. Mill production averages about 30 tons per hour.

A roll shop adjoins the mill building, and houses two 34 in. lathes, two 42 in. lathes, one 44 in. lathe, and one roll grinder.

Running across the lower ends of three of the merchant mills are two parallel shipping buildings, one 333 ft. 10 in x 100 ft. with one 20 ton crane, and the other 418 ft. x 100 ft., with three 20 ton cranes.

The cold drawn shafting department, termed No. 3 mill, has a capacity of 30,000 gross tons per year, made up of ½–2 in. cold drawn rounds, 5/16–½ in. coiled rounds, ⅞–2½ in. turned stock, plain or reinforced mower bars, etc.

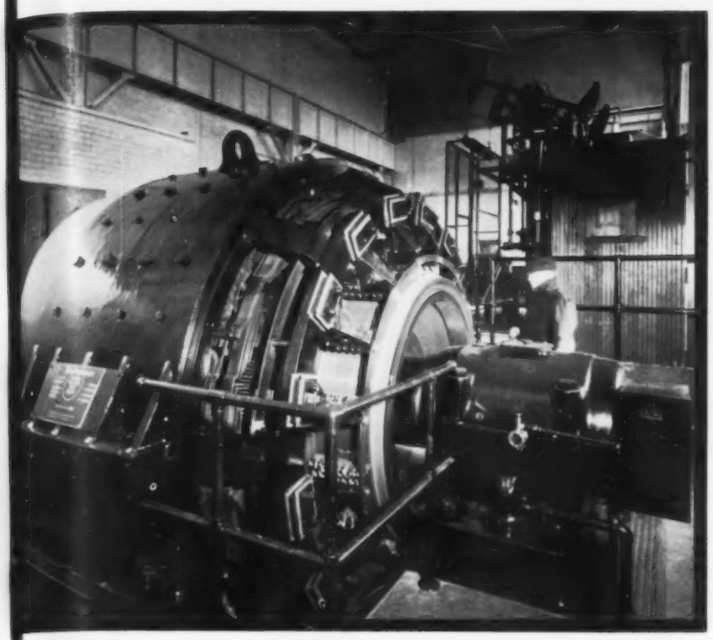
The equipment is housed in a building 480 ft. x 110 ft. The north 160 ft., separated from the rest of the mill by a partition, houses the pickling equipment and black bar stock. The equipment of the mill proper occupying the remaining 320 ft. of the building, consists of three cold drawing machines, three wire drawing blocks, four turning machines, eight cutoff machines, three shears, eight straighteners, two wire straighteners, one cold rolling mill, one hydraulic shear, one gag press, and other auxiliary equipment.

The principal products are cold drawn and turned and polished shafting. A considerable tonnage of cold drawn screw machine stock, stock for cold heading and various sizes of plain or reinforced mower bars, straightened and cold rolled when desired, are also produced.

Immediately following the last stand of the 21 in. billet mill is a flying bar and billet shear.

SERVICE DEPARTMENT

The entire supply of electric power is purchased from the local utility company at 13,200 volts, 60 cycles. Incoming lines feed to an indoor substation containing two transformer banks, each of three single-phase 2500 kva. units and one bank of three single-phase 2000 kva. units, all of 13200/2200 volts. Additional lines feed an outdoor substation containing three three-phase transformers, each of 7500 kva., 13200/6600 volt rating. Incoming transformers thus total 43,500 kva. capacity, of which 22,500 kva. is at 6600 volts and 21,000 kva. is at 2200 volts. Against these capacities are connected loads of 22,270 motor hp. and 3300 kva. of transformer banks on the 6600 volt system, and 27,518 motor hp. and 8160 kva. of transformer banks on the 2200 volt system. The older parts of the plant are fed from the 2200 volt system, the 6600 volt system feeding only the recently installed 32 in. and 21 in. mills, and the recently electrified main drives of No. 2 merchant mill. The plant sets up a 30 min. demand of about 17,000 kw., and, due to



A 4000 hp., 700 volt, 75-165 rpm. d-c. motor drives the 32 in. blooming mill under Ward-Leonard control.

the considerable amount of synchronous machinery installed, a power factor of 93 to 100 per cent is maintained at the central substation.

These transformers are located at the central substation, which also includes four 1000 kw., 230 volt motor-generator sets for auxiliary d-c. power. Additional sets for auxiliary d-c. power include two 1000 kw. sets at the coke plant substation, a 1500 kw. set in the 32 in. mill motor room, a 1000 kw. set in No. 2 mill motor room, a 1000 kw. set in No. 5 mill motor room and a 500 kw. set at the cold draw department.

Auxiliary a-c. power is supplied at 440 volts and lighting circuits are 110 volts. The auxiliary transformers, previously mentioned, total 11,460 kva. capacity, and are located at various load centers around the plant.

Plant steam usage is provided by four boilerhouses. One of these is located at the coke plant, and contains three 500 hp. boilers, fired by coke breeze and coal on chain grate stokers. Gas may also be used if desired. Steam is generated at 225 lb. pressure, 500 degree F. total temperature, and supplied to the coke plant and open hearth, with a demand of about 45,000 lb. per hr. Boiler feed treatment in this house is entirely internal.

The remaining houses are at the blast furnace plant. One of these consists of two 1500 hp. units, fired with blast furnace gas, with oil as a standby. Steam from these units, at 400 lb. pressure, 700 degrees F. total temperature, supplies the three blast furnace turbo-blowers, representing a demand of 120,000 lb. per hr. Economizers and air preheaters are provided on each unit. Feed water is composed of condensate from the blowers and evaporated make-up. A cross-connection with a reducing valve connects the 400 lb. system to the 150 lb. system, which is also fed by the other two boilerhouses. One of these contains ten 350 hp. boilers and the other, four 500 hp., boilers. Two mill drive engines, the standby blast furnace blowers, and auxiliary plant usage is supplied from this system, which encounters demands up to 150,000 lb. per hr. It is planned to eliminate some of the 150 lb. boilers by the installation of another 400 lb. unit. Feed water for these boilers is treated in a continuous hot process lime-and-soda plant, and an internal after-treatment of phosphate is used.

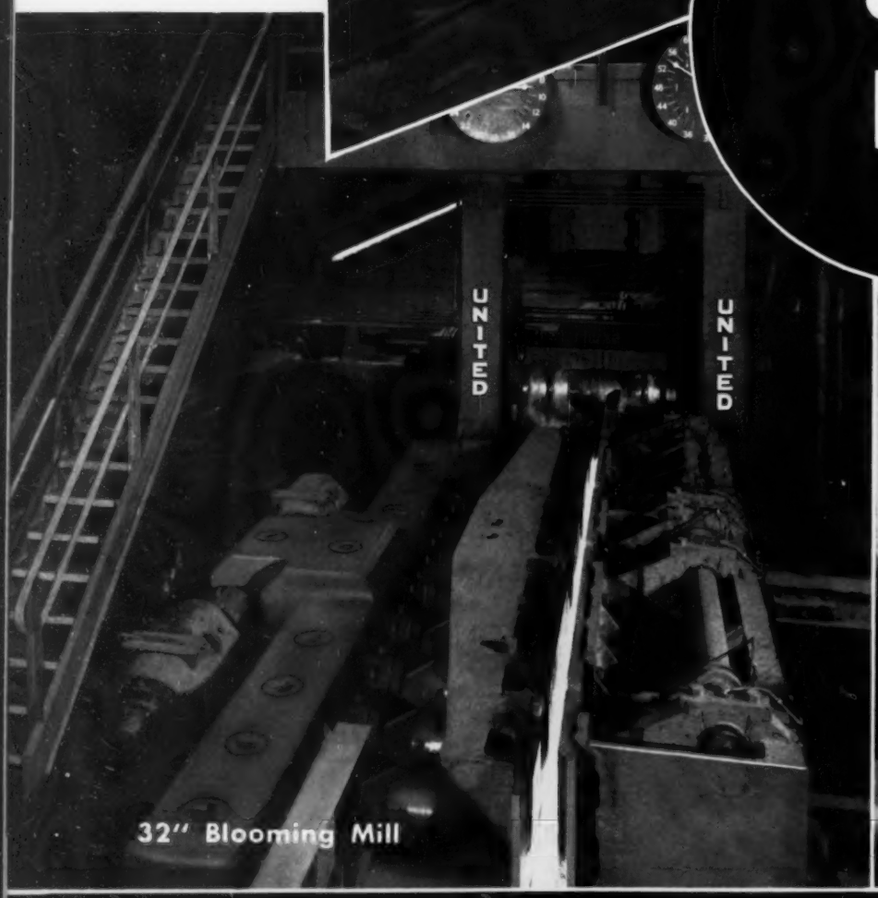
Water requirements for the plant are met by two pumphouses, with some purchased city water. The main house, located near the blast furnaces, contains two 20,000 gal. per min. centrifugal pumps and one 14,000 gal. per min. pump, and takes water from the Calumet River. One of the large pumps is motor driven, while the remainder are driven by steam turbines. Pressure is maintained at 35 lb. per sq. in. Two 25,000 gal. per min. centrifugal pumps, one motor driven and one steam driven, supply condenser water at 50 ft. head.

At the coke plant is another pumphouse, containing four centrifugal pumps, two of 5000 gal. per min., and two of 10,000 gal. per min. One of the larger units is turbine driven, and the balance are motor driven. This house also takes water from the river, and supplies the coke plant and open hearth.

The billet mill is driven by individual d-c. motors, operated as a unit under variable voltage control.

Continuous Billet Mill

UNITED EQUIPMENT



32" Blooming Mill

Billet Flying Shear

UNITED ENGINEERING *and* FOUNDRY COMPANY

Pittsburgh · Pennsylvania

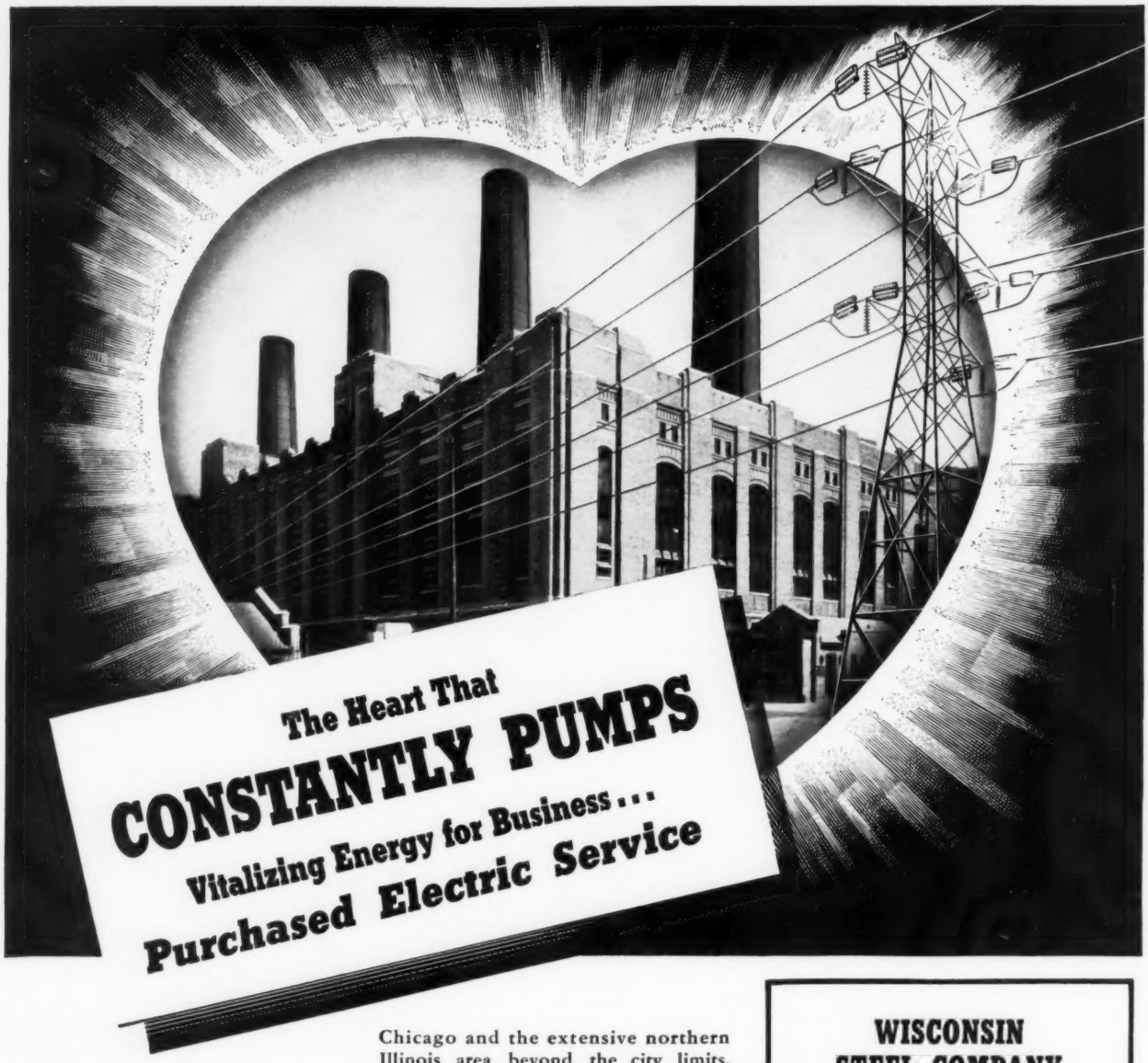
Transfer from Blooming Mill
to Billet Mill

N Wisconsin STEEL COMPANY

UNITED PLAYS ITS PART
IN THE
PREPAREDNESS PROGRAM

Up and Down Cut
Billet Shear

DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND · DOMINION ENGINEERING WORKS, LTD.,
MONTREAL, P. Q. · UNITED INTERNATIONAL, S. A. PARIS, FRANCE · SHIBAURA-UNITED ENGINEERING CO., TOKYO, JAPAN



■ No wonder 97 per cent of business and industry in this territory use purchased electric service. Purchased electric service flowing into store, office, and factory provides the vitalizing force of production. Unseen, unheard, yet always ready to provide the energy for machines, the source of illumination. Although you may never give it a thought, you know it is there—always will be there, at any time, whenever you need it, in any quantity.

Chicago and the extensive northern Illinois area beyond the city limits, served by the companies listed below, enjoy unusually favorable utility power facilities: *Dependability* of well engineered, carefully maintained central generating stations and transmission and distribution equipment... *Flexibility* of a comprehensive and diversified power system designed to meet present needs and anticipate future requirements... *Economy* through mass power production and advantageous rates for every type of power use. Our engineers will gladly furnish detailed information.

POWER SALES DEPARTMENTS

COMMONWEALTH EDISON COMPANY
PUBLIC SERVICE COMPANY OF NORTHERN ILLINOIS
ILLINOIS NORTHERN UTILITIES COMPANY
WESTERN UNITED GAS and ELECTRIC COMPANY

WISCONSIN STEEL COMPANY

... a user of dependable

Purchased Electric Service

•

Like many another large industrial plant in northern Illinois, the Wisconsin Steel Company relys on purchased electric service to provide a constant, flexible and economical source of power. In the production of alloy and carbon steel and pig iron, purchased electric power helps assure continuous operation and plays a vital part in insuring the uniformity of Wisconsin Steel Company's high-quality products. The entire electric power supply is furnished by the Commonwealth Edison Company.

The Commonwealth Edison Company provides electricity within the city of Chicago. The Public Service Company of Northern Illinois and the Western United Gas and Electric Company serve electricity and gas in Chicago suburbs and in outlying areas beyond; the Illinois Northern Utilities Company, in an extensive Northern Illinois territory reaching westward to the Mississippi River.

TIMKEN BEARINGS AT WISCONSIN STEEL WORKS

Tapered Roller TIMKEN BEARING EQUIPPED

32" United Blooming Mill at Wisconsin Steel Works.

TIMKEN Tapered Roller Bearings are used in many important applications at the Wisconsin Steel Works.

TIMKEN Bearing applications on the 32" blooming mill comprise the front and back table rollers, table drive, screwdown mechanism and manipulators. Approach and delivery tables (adjacent to the 32" mill) and drive are also equipped with TIMKEN Bearings.

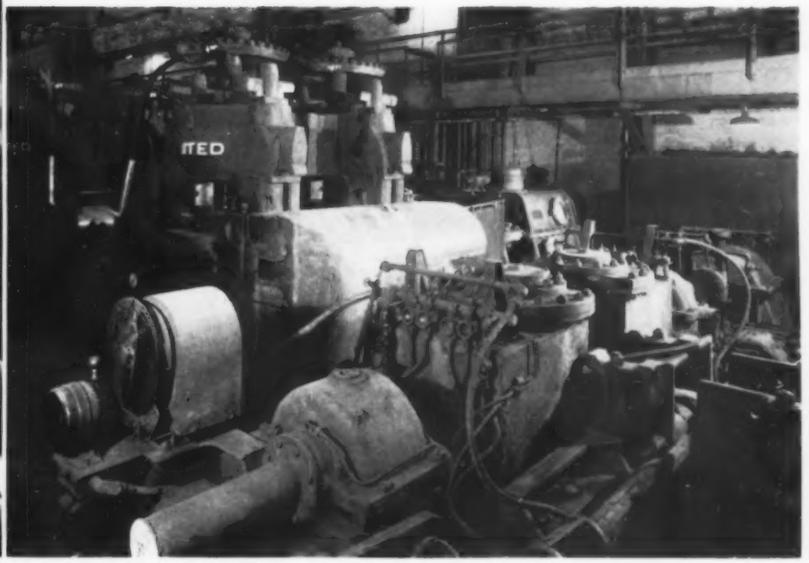
In the transfer and cooling beds, used in conjunction with the merchant mill, TIMKEN Bearings are used on the table rollers, drives and line shafts. They are also used on both ends of the pinion, intermediate and gear shafts of the No. 1 and No. 2 vertical edger drives.

Flying shear, crop shear, shear runout table, billet push-off rolls and drive, roll lathe, billet pusher and cranes represent but a portion of the miscellaneous equipment that is Timken Bearing Equipped.

The wide application of TIMKEN Bearings in the Wisconsin Steel mill (this statement applies to practically every mill in America, large or small) is the result of definite performance proof of their dependability. You can have it in your new or redesigned equipment by specifying TIMKEN Bearings.

TIMKEN
TAPERED ROLLER BEARINGS

Transfer tables. Note long row of drives all of which are Timken Bearing Equipped as are rolls and line shaft.

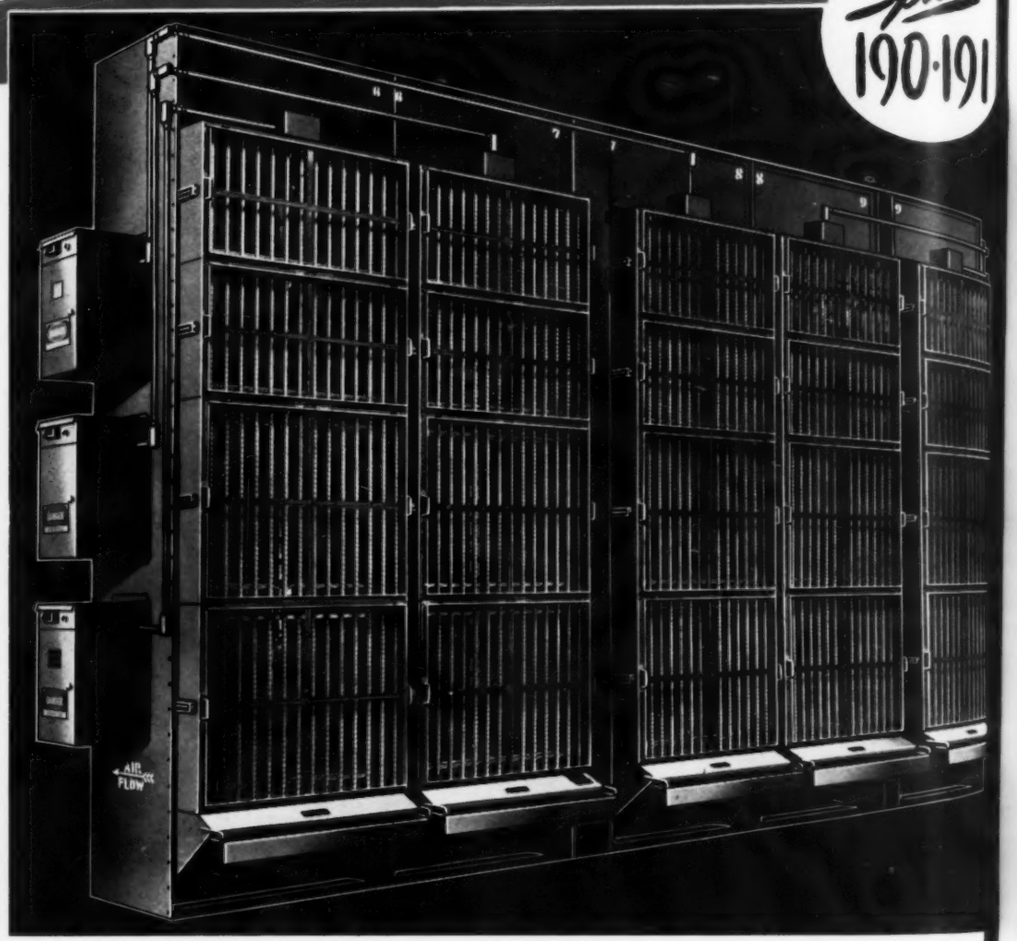


Vertical edger drives. TIMKEN Bearings used on both ends of pinion, intermediate and gear shafts.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

See the ELECTRO-MATIC at the show

Space 190-191

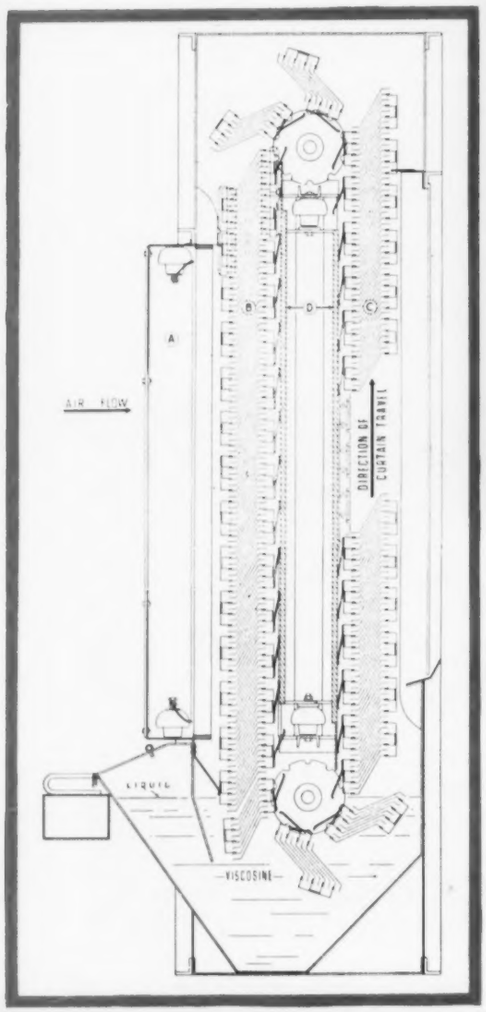


A—IONIZING UNIT—*where dust and smoke particles receive positive ion charge before entering filter curtain.*

B—FRONT CURTAIN—*in which most of the dust particles are precipitated or impinged on the charged plates.*

C—REAR CURTAIN—*which is also charged to collect any dust particles that may escape the front curtain.*

D—BUS BARS—*thru which electrical potential is applied to the positive plates in both front and rear curtains.*



...and a demonstration of collecti dust, soot, and smoke electricall

The Electro-Matic Filter, the most outstanding air cleaning development of the decade, will be displayed and demonstrated at the Iron and Steel Exposition in Chicago. Don't miss the opportunity to see the new Electro-Matic in action! Remember Space 190-191.

AMERICAN AIR FILTER COMPANY, INC.

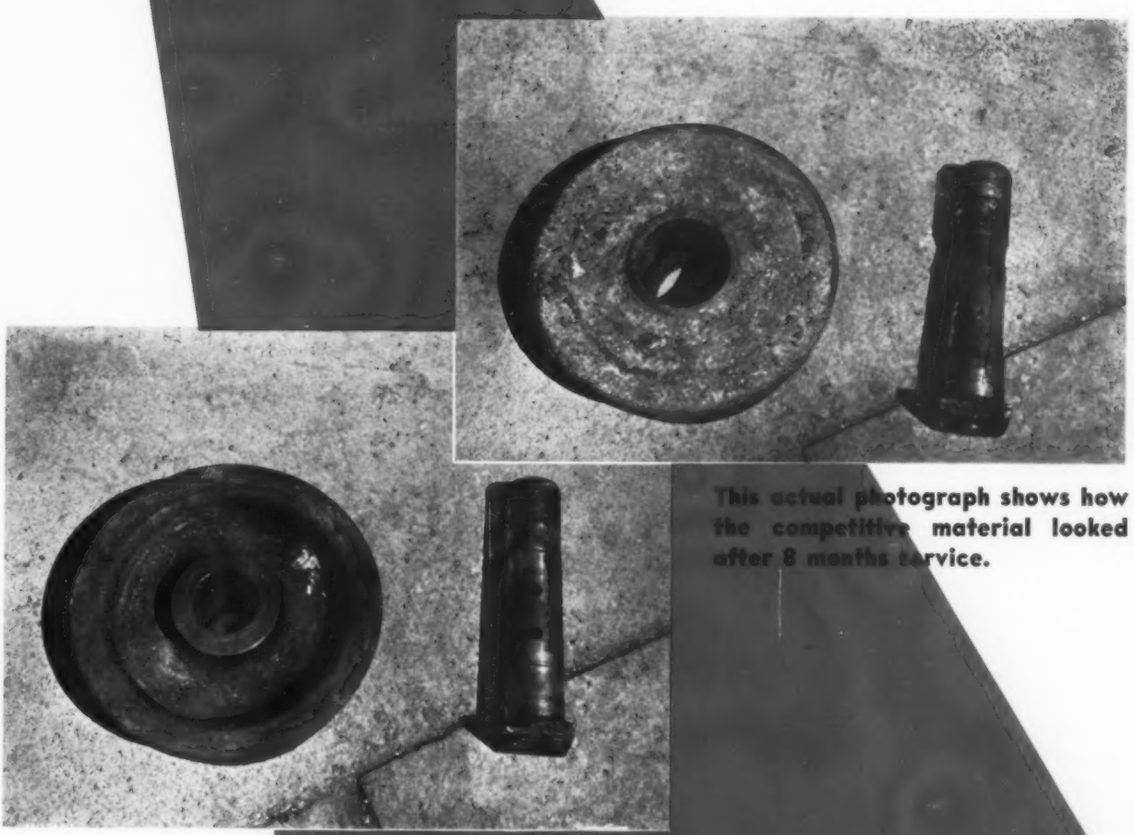
INCORPORATED

634 CENTRAL AVE. LOUISVILLE, KY.

AIR FILTRATION DUST CONTR(

Here's proof

that "Tool Steel" wheels and pins lasted 3 times the life of competitive material on a pig machine at Wisconsin Steel Co.



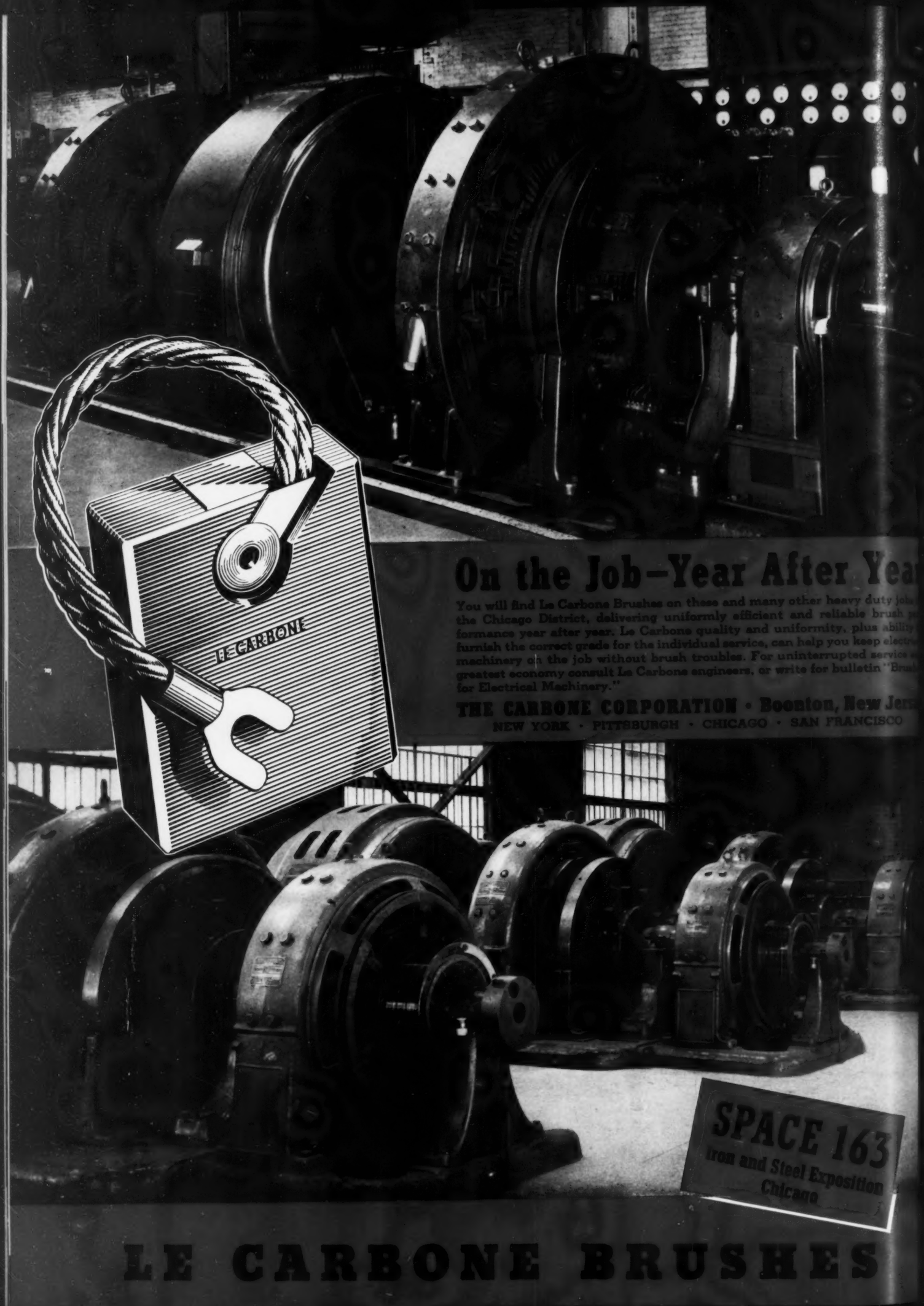
This actual photograph shows how the competitive material looked after 8 months service.

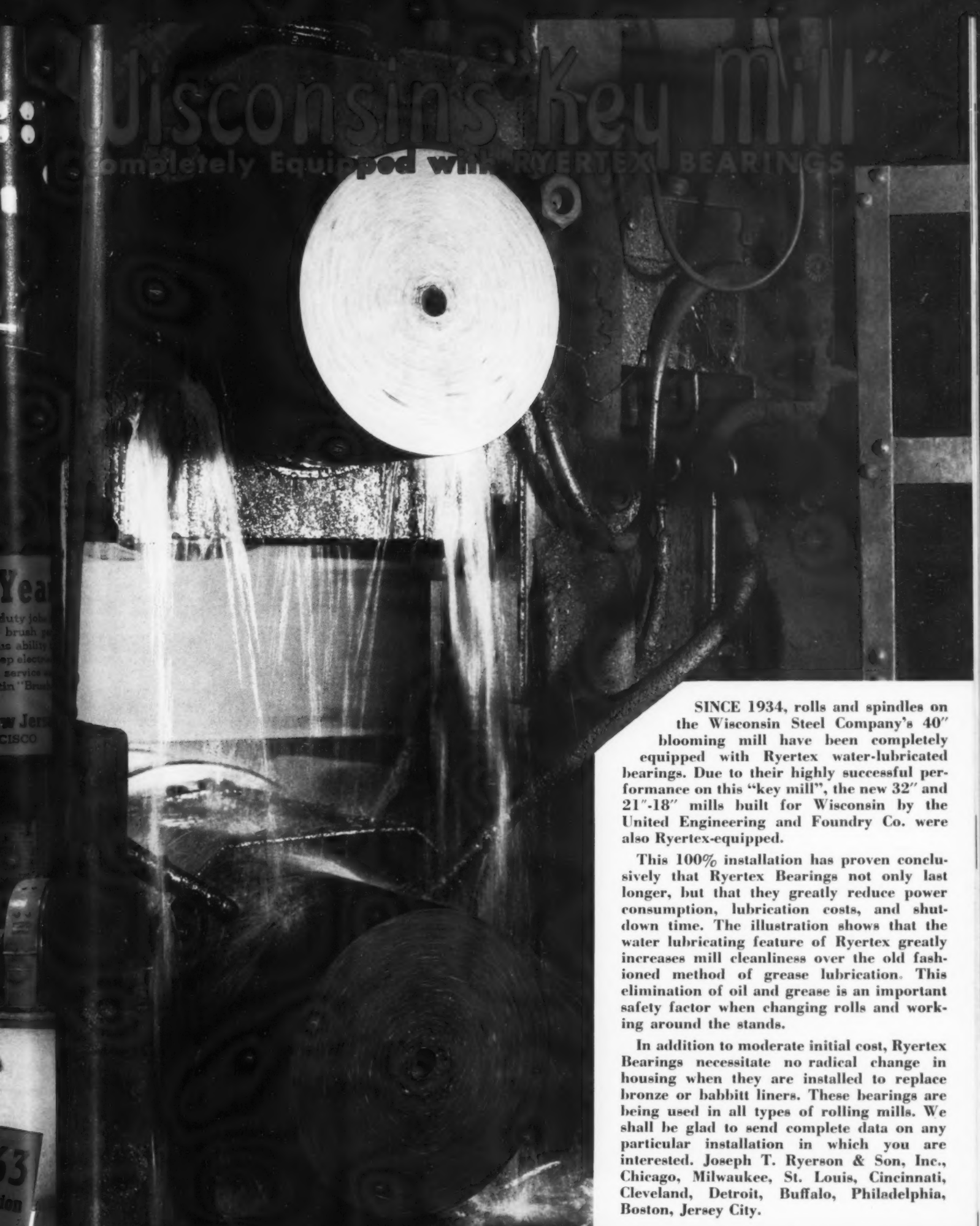
"Tool Steel" wheels and pins were installed and this photograph shows one of them taken after 2 years of service; wear only 1/64" between the pin and wheel base.

Here is another example of the savings gained by using "Tool Steel" hardened products.

THE TOOL STEEL GEAR & PINION COMPANY

CINCINNATI, OHIO


LE CARBONE
On the Job—Year After Yea
You will find Le Carbone Brushes on these and many other heavy duty jobs
the Chicago District, delivering uniformly efficient and reliable brush p
formance year after year. Le Carbone quality and uniformity, plus ability
furnish the correct grade for the individual service, can help you keep electr
machinery on the job without brush troubles. For uninterrupted service
greatest economy consult Le Carbone engineers, or write for bulletin "Brus
for Electrical Machinery."
THE CARBONE CORPORATION • Boonton, New Jer
NEW YORK • PITTSBURGH • CHICAGO • SAN FRANCISCO
SPACE 163
Iron and Steel Exposition
Chicago
LE CARBONE BRUSHES



SINCE 1934, rolls and spindles on the Wisconsin Steel Company's 40″ blooming mill have been completely equipped with Ryertex water-lubricated bearings. Due to their highly successful performance on this "key mill", the new 32″ and 21″-18″ mills built for Wisconsin by the United Engineering and Foundry Co. were also Ryertex-equipped.

This 100% installation has proven conclusively that Ryertex Bearings not only last longer, but that they greatly reduce power consumption, lubrication costs, and shutdown time. The illustration shows that the water lubricating feature of Ryertex greatly increases mill cleanliness over the old fashioned method of grease lubrication. This elimination of oil and grease is an important safety factor when changing rolls and working around the stands.

In addition to moderate initial cost, Ryertex Bearings necessitate no radical change in housing when they are installed to replace bronze or babbitt liners. These bearings are being used in all types of rolling mills. We shall be glad to send complete data on any particular installation in which you are interested. Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Cincinnati, Cleveland, Detroit, Buffalo, Philadelphia, Boston, Jersey City.

RYERSON

Motor Leads, Feeders and Control wires for the blooming mills and the continuous merchant mill of Wisconsin Steel Works are braided Okonite, manufactured by The Okonite Co., Passaic, N. J. Offices in principal cities.

OKONITE

INSULATED WIRES AND CABLES

The nine Open Hearth furnaces of the Wisconsin Steel Company are typical of the **635** furnaces equipped with our patented improvements, including:

VENTURI PORTS SLOPING BACK WALLS

DANFORTH-PETERSON CHECKERWORK

TAPERED DOOR FRAMES FUEL MIXING BURNERS

and using our **SODIUM FLUORIDE PROCESS** with rimming steels . . . Our Licensees, representing over 90% of the steel producing capacity of this country, include:

Alan Wood Steel Company
Algoma Steel Corporation, Ltd.
Allegheny Ludlum Steel Corporation
American Rolling Mill Company
American Steel Foundries
American Steel & Wire Company
Andrews Steel Company
Bethlehem Steel Company
Carnegie-Illinois Steel Corporation
Central Iron & Steel Company
Colorado Fuel & Iron Corporation
Continental Steel Corporation
Empire Sheet & Tin Plate Company
Ford Motor Company
Great Lakes Steel Corporation
Inland Steel Company
Jones & Laughlin Steel Corporation
Keystone Steel & Wire Company
Laclede Steel Company

Lukens Steel Company
Marion Steam Shovel Company
McConway & Torley Corporation
National Tube Company
Otis Steel Company
Pittsburgh Crucible Steel Company
Pittsburgh Steel Company
Republic Steel Corporation
Sharon Steel Corporation
Sheffield Steel Corporation
Steel Company of Canada, Ltd.
Symington-Gould Corporation
Tennessee Coal, Iron & R.R. Co.
Weirton Steel Company
Wheeling Steel Corporation
Wickwire Spencer Steel Company
Wisconsin Steel Company
Youngstown Sheet & Tube Company

As well as 17 Licensees in foreign countries.

OPEN HEARTH COMBUSTION COMPANY

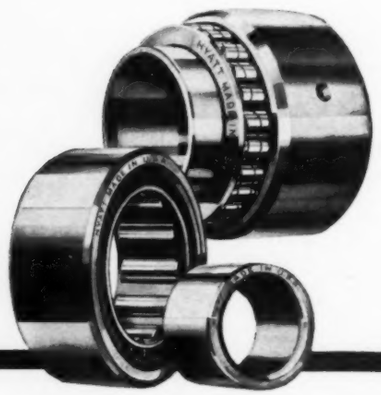
GEO. L. DANFORTH, JR., *President*

LICENSORS DESIGNERS CONSULTANTS

310 South Michigan Avenue . . Chicago, Illinois

At WISCONSIN STEEL, sturdy Hyatts serve – *ALL ALONG THE LINE!*

On your inspection trip, you'll see Hyatt Roller Bearings used all along the line. In cranes, cars, motors, tables and miscellaneous mill equipment their widespread use today is due to their dependable performance in the past. Year after year, in mill after mill, Hyatts have served long and well... avoiding wasteful friction... prolonging equipment life . . . cutting maintenance costs. Even under the tough shocks and heat of steel mill jobs, Hyatts keep your machinery young and full of life because they are built for such work. Are Hyatts working for you? Hyatt Bearings Division, General Motors Sales Corp., Harrison, New Jersey; Detroit, Chicago, Pittsburgh and San Francisco.

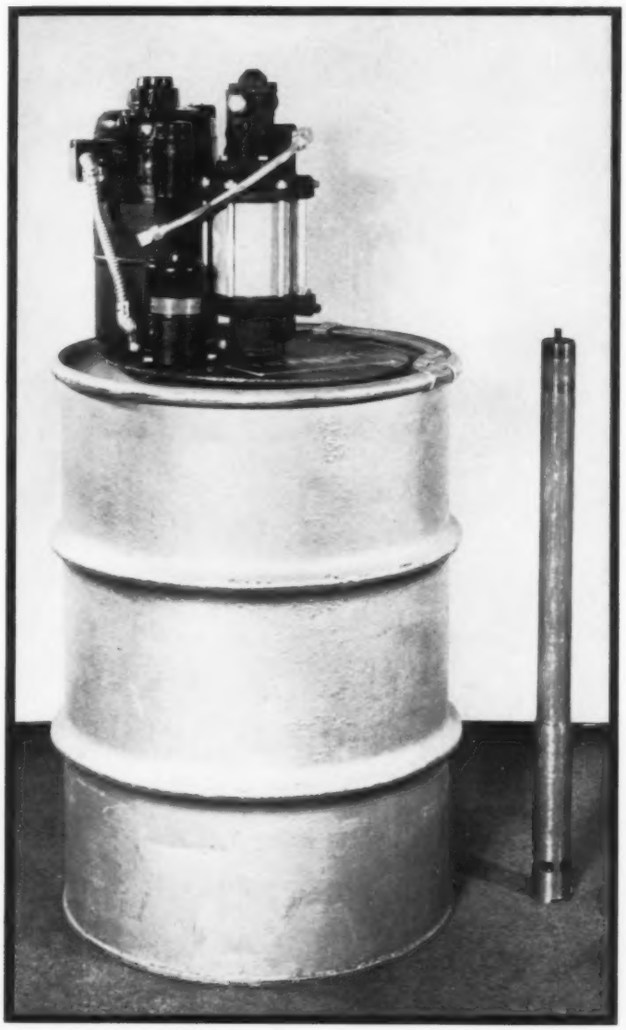


HYATT ROLLER BEARINGS

TRABON

Designed for

INDUSTRY



Realizing the need in industry for a sturdy, dependable pump to handle heavy lubricants from the original containers, the **TRABON** organization has perfected their line of **Hydraulically Operated Barrel Pumps.**

Capable of handling heavier or stiffer greases than is customary with the conventional barrel pumps, and designed for **continuous operation.**

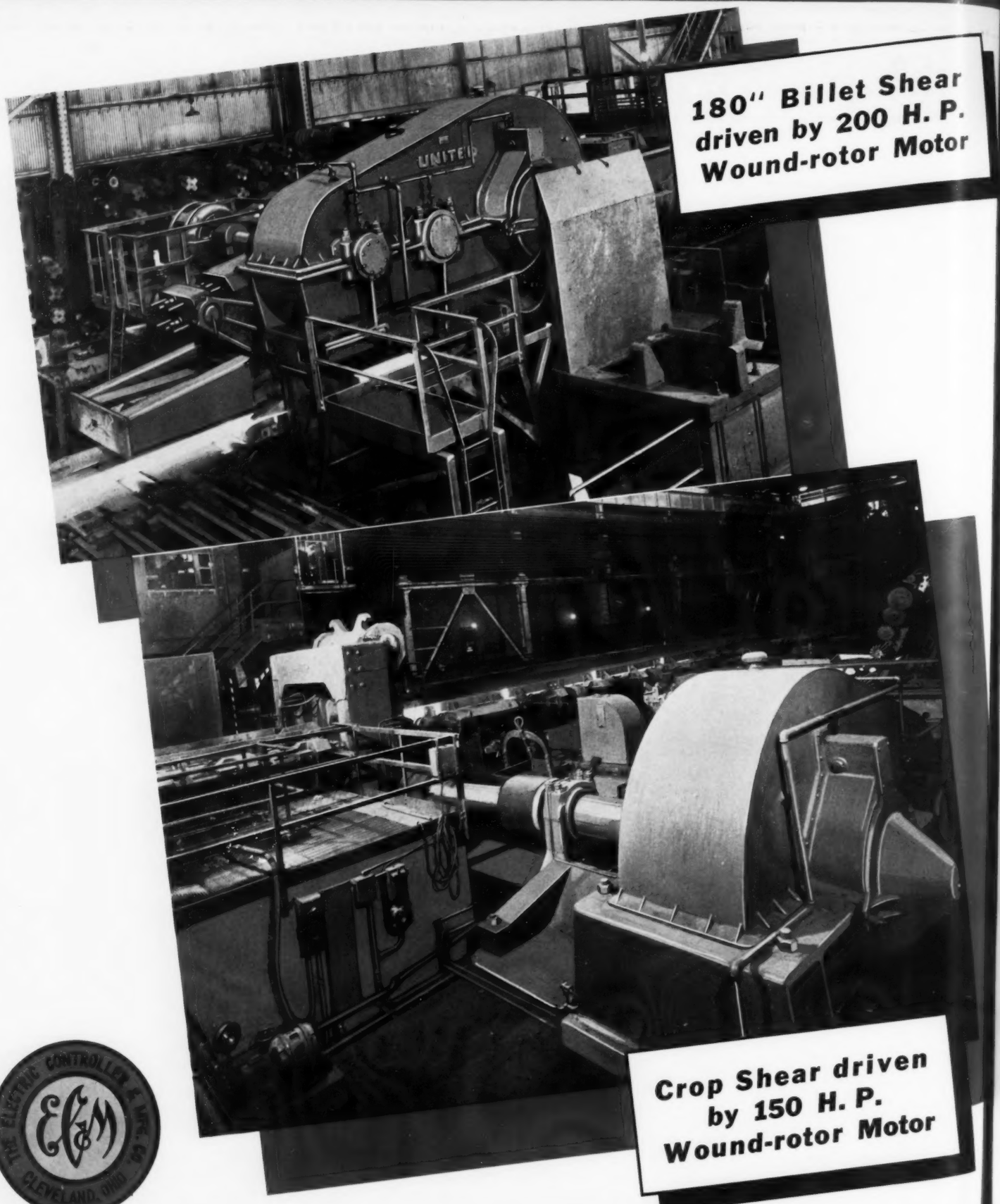
Stop at Booth No. 200 for demonstration

See our other advertisement on page 30-Y featuring the new TRABON DESCALING NOZZLE

TRABON ENGINEERING CORPORATION

1814 E. 40TH ST. CLEVELAND, O.

A-c Auxiliary Drives a



180" Billet Shear driven by 200 H. P. Wound-rotor Motor

Crop Shear driven by 150 H. P. Wound-rotor Motor

THE ELECTRIC CONTROLLER & MFG. CO. EC&M CLEVELAND, OHIO

HEAVY DUTY MOTOR CONTROL FOR CRANES, MILL DRIVES AND MACHINERY • BRAKES • LIMIT STOPS • LIFTING MAGNETS AND AUTOMATIC WELD TIMERS.

EC&M CONTROL

Wisconsin Steel Works

EC&M Frequency Relay Controlled

These heavy-inertia loads start smoothly . . . the motors accelerate quietly and without line disturbances under this system of control.

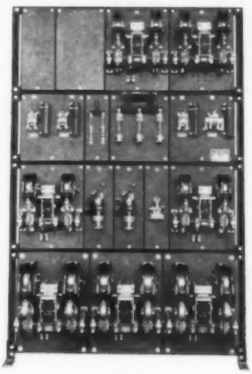
HERE at the Wisconsin Steel Works of the International Harvester Company, you will find the last word in control for a-c wound rotor motors on Auxiliary Drives. It is EC&M Frequency Relay Magnetic Control which requires no conversion units but operates directly from the a-c source of power.

The Frequency Relay Controllers match motor torque exactly to the requirements of the load. From the motor curves, torque values are carefully pre-determined and then accurately matched during acceleration by Frequency Relay Control. This means very smooth operation . . . minimum disturbance to motor, machinery and power system.

Investigate the new EC&M Frequency Relay Method of Control. It is modern, efficient, economical and engineeringly right.

EC&M FREQUENCY RELAY MAGNETIC CONTROL

Your opportunity to examine and operate this new method of control for A-c Wound-rotor Motors



Visit Booth No's 204, 5, 6 & 7

This new control will operate a wound-rotor motor and will be shown in 2 forms.

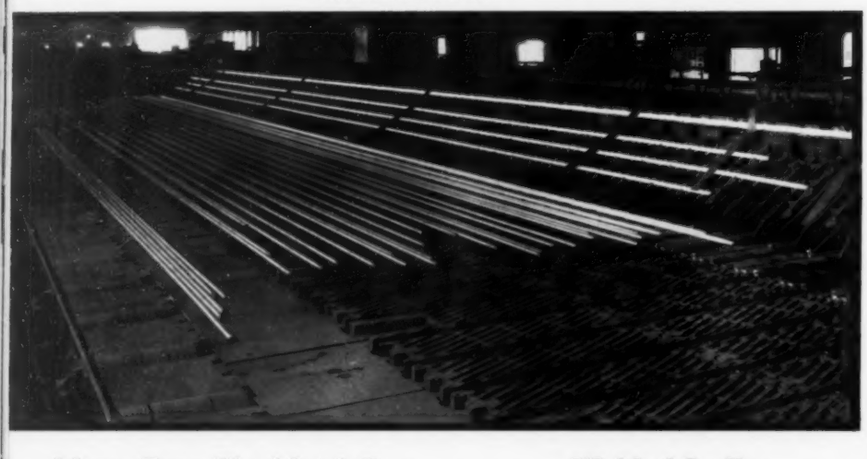
1- As a standard reversing-plugging controller for cranes, mill tables, etc.

2- As a quick-stop-by-plugging controller in which frequency relays replace the zero-speed switch or similar mechanical device. Stopping is accomplished electrically - - no mechanical connection to drive is required to remove reverse-power plugging contactor.

TIME-CURRENT System for Direct Current Motors
FREQUENCY RELAY System for Alternating Current Motors

TREADWELL

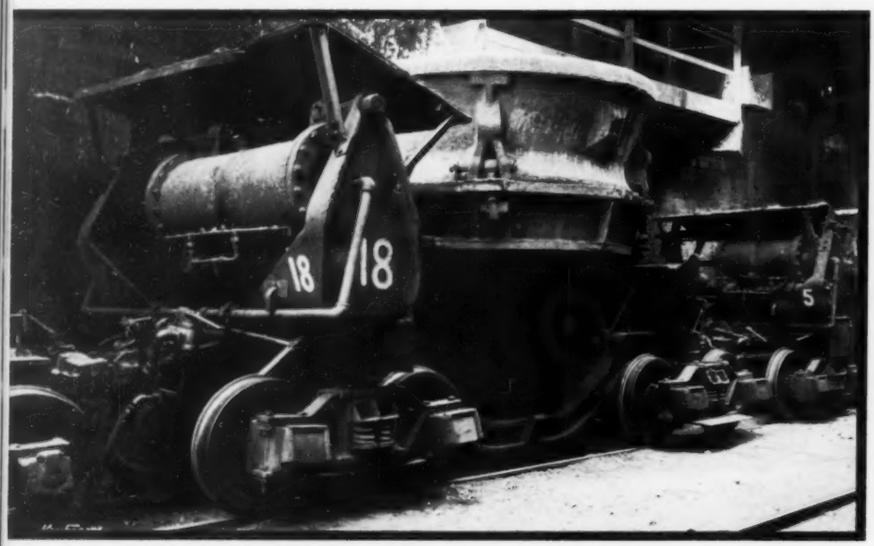
Merchant Mill Hot Bed



Cold Rolling Mills
Tables and Transfers
Hot Beds
Coilers
Shears
Merchant Mills
Steel and Iron Castings

Mixer Type Hot Metal Cars
Steam, Air or Motor Dump Cinder Cars for Blast Furnace or Open Hearth Use
Single, Double or Triple Pot Crane Dump Cinder Cars
Scrap Charging Cars

Welded Ladles
Charging Boxes
Ingot Mold Cars
Stacks
Galvanizing Kettles
Gas Piping
Stand Pipes
General Plate Work



330 Cu. Ft. Steam Dump Cinder Cars

120 Ton Open Hearth Ladle

M. H. Treadwell Co., Inc.
New York, N. Y.

208 South LaSalle Street
Chicago, Ill.

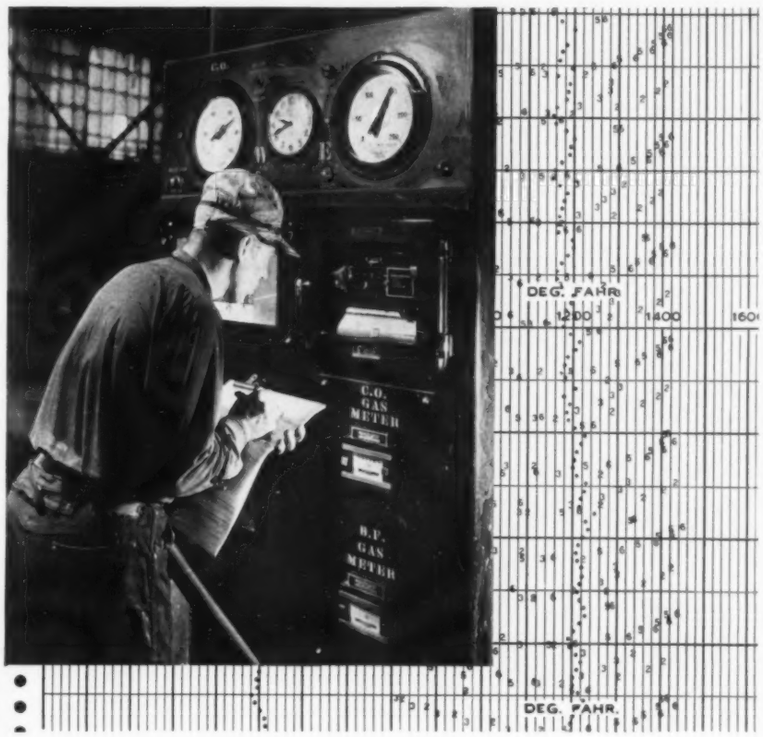
Treadwell Engineering Co.
Easton, Pa.

SALES OFFICES

2113 Farmers Bank Building
Pittsburgh, Pa.

Treadwell Construction Co.
Midland, Pa.

140 Cedar Street
New York, N. Y.



IT'S *Easier* TO READ PYROMETERS
When They're Multicolor MICROMAX

Pyrometer records for open-hearths and other big furnaces are much easier to read when each temperature is recorded in its own color by the Micromax Multicolor Pyrometer. This type of record is used at Wisconsin Steel Co., where 5-point instruments show temperatures of air, gas, and stack, in rotation.

Wisconsin men find that errors in reading are reduced, and that readings are made more quickly on these recorders than on single-color instruments. . . . To see this, a visitor at Wisconsin Steel has only to compare the one-color chart reproduced above with the multicolor charts actually in the open-hearth shop.

The use of Micromax Pyrometers in steel plants is outlined in the following publications, sent on request:

Bulletin 841—Automatic Reversal of O-H Furnaces

Bulletin N-33B-685(1)—Rolling Temperatures Recorded By Speedomax

Bulletin N-33B-600B—Temperature Limit Control For Furnace Roofs

Catalog N-33A-642—Blast Furnace Temperatures Recorded—Controlled by Micromax

Look to L&N for:

Micromax Controllers, Recorders & Indicators
Speedomax Recorders
Manually-Operated Indicators
Metermax Combustion Control
Centrimax Flowmeters

Instrument and Control Information

Potentiometers - Bridges
Standards - Galvanometers & Dynamometers
Test Sets & Equipments
Photometers - Synchronous Apparatus

Vapocarb-Hump Hardening Furnaces
Homocarb Carburizing Furnaces
Homo Nitriding Furnaces
Homo Tempering Furnaces

Jrl Ad N-0600C(4)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Here's Help For The First Helper

Additional help for today's busy helpers in open-hearth shops is provided by this brand-new model of the time-tried L&N Furnace Pressure Controller.

It holds pressure wherever the helper wants it; it even responds to changes as small as a thousandth of an inch of water if such sensitivity is needed. It can be put to work by simply touching a button on its case; and when the helper wants to take control himself, another touch turns regulation over to the Controller's manually-operated push-button station, which is also built into the case.

Left, L&N Pressure Controller. Right, Micromax Pyrometer.

The amount of furnace pressure can be changed by simply turning a knob, which is a great convenience when it's necessary to shift the pressure in a hurry. . . . Space in narrow aisles or control rooms is saved because this controller mounts flush in the control panel.

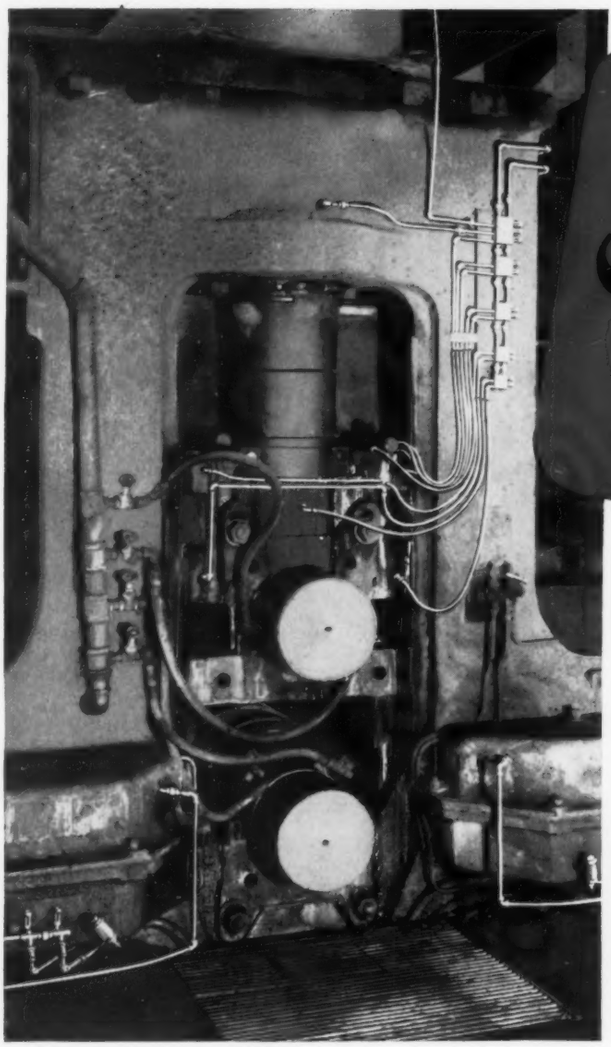
With all its external convenience features, the L&N Furnace Pressure Controller uses, inside, the same sturdy, simple, foolproof machine it has always used. It's a better buy than ever, because its dependability is proved and its convenience increased. See Catalog N-01A-600.

New Catalog of Thermocouples

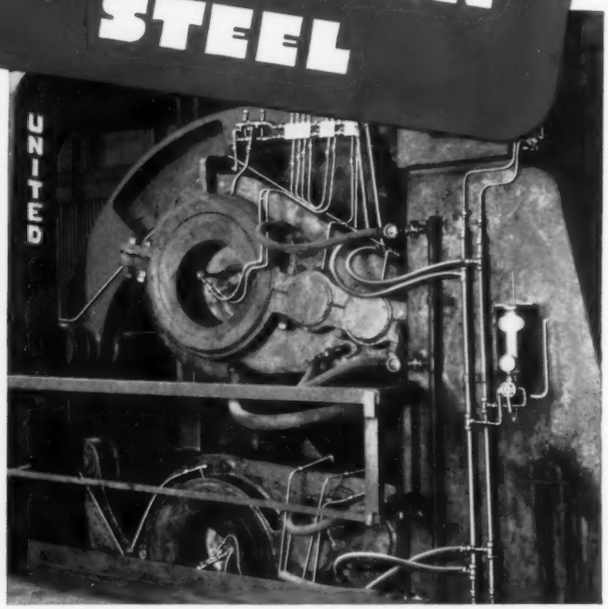
The first edition of the L&N Thermocouple Catalog compresses into 40 illustrated pages, the practical facts about thermocouples, their protection tubes and their parts.

There's no theory in the book — instead, there's a table showing which couples meet which conditions at which temperatures. Another table tells about protection tubes, to help you select the one your furnace needs. All L&N couples are illustrated.

In general, we've tried to make the catalog useful to every thermocouple user, whether or not he knows much about the devices. Thermocouples are the simplest and most reliable devices for detecting high temperature in any industrial furnace which can use them, and we shall be glad to send this catalog to anyone interested in measurement, recording or automatic control of temperature.



Farval AT WISCONSIN STEEL



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CENTRALIZED SYSTEMS OF LUBRICATION

THE AMPLIDYNE

... A New Tool of Many Uses

By F. MOHLER
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Presented before A. I. S. E., Chicago District Section, February 6, 1940 and Pittsburgh District Section, March 19, 1940.

▲ THE electrical engineer is continually searching for new and improved methods of controlling power. To make a 10,000 hp. motor maintain a rolling speed exactly in proportion to the blood pressure of the production superintendent, or, perhaps the color of his face, is a fair summary of his goal. Although some of the rolling crews will in all probability violently disagree, the actual variation in energy that can be measured in the change in a man's blood pressure or the color of his face is extremely small, but the energy to control the 10,000 hp. motor is quite appreciable. In addition, the blood pressure of some superintendents has a habit of changing rather suddenly, and this would really call for some rapid action. Furthermore, dire consequences sometimes occur when equipment fails to respond to the superintendent's blood pressure. Thus, the eternal search for better means of amplifying power which are both fast and reliable.

Believe it or not, a very definite step was made toward this goal when it was first discovered that the speed of a d-c. motor could be controlled by a rheostat in its field circuit. Progress since has been rapid, and numerous control amplifiers have been developed, such as exciters, which are controlled by means of rheostats and various types of regulators. Another fairly recent development in control amplifiers is grid control of power tubes and rectifiers. However, from the standpoint of economy, maintenance, reliability, power amplification, speed of response or regenerative difficulties, none of these has quite reached our goal. The most

FIGURE 1—The armature of a simple generator produces a flux as if it were a coil stationary in space.

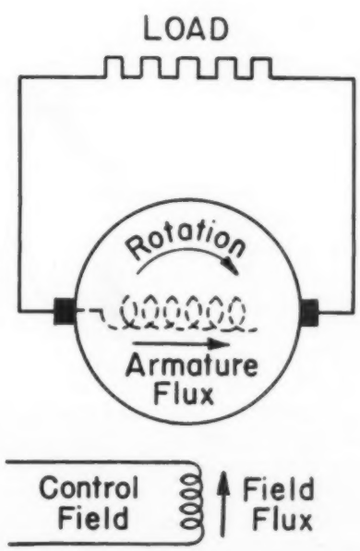
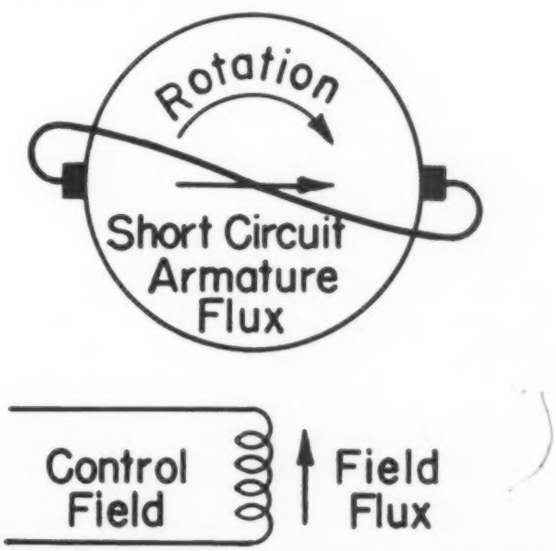


FIGURE 2—If the armature of a simple generator is shorted, small field flux produces full load armature current and a large armature flux.



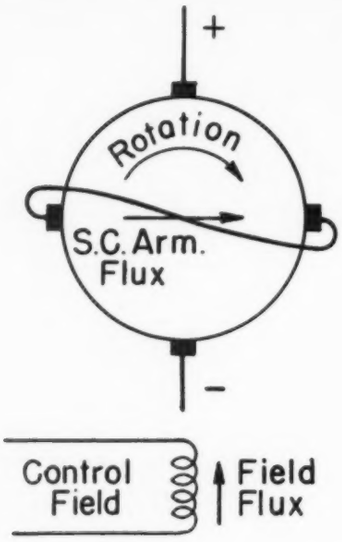


FIGURE 3—If brushes and poles are added to the generator in Figure 2, voltage is produced at the added brushes.

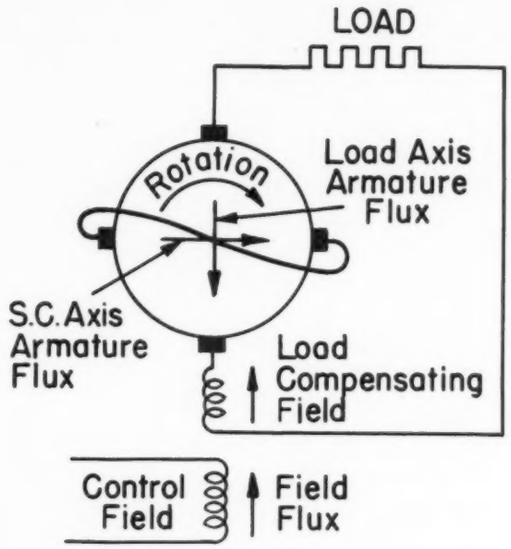


FIGURE 4—If a load is connected to the load axis brushes, the load current itself will produce armature flux opposing the control field.

recently developed power control amplifier is the amplidyne, and because of its high amplification factor, speed of response, and reliability, it bids fair not only to attain our aforesaid goal, but offers a new tool for solving many industrial application problems.

An understanding of this machine and its characteristics is essential before discussing its many applications and possibilities.

DESCRIPTION

First, let us review briefly our knowledge of the simple conventional d-c. generator. Referring to Figure 1, we know that when field is applied to a generator, an emf. or voltage will be generated proportional to the field flux, also that the armature current is proportional to this voltage, and to the armature circuit resistance. Furthermore, a flux is produced in the armature which is proportional to the load or armature current. This resulting flux is at right angles, or in quadrature, to the field flux, and acts just as though the armature were a stationary coil in space. In other words, the flux caused by the armature or load current is always at a right angle to the field flux producing the armature current, and is stationary, even though the armature is continuously rotating. This armature flux which is proportional to the armature current is commonly known as armature reaction. In conventional machines this is a nuisance from the standpoint of commutation, and is neutralized by use of a commutating interpole or compensating pole face winding. In the case of the amplidyne, however, this flux will be used.

If the load resistance is made negligible by short circuiting the armature, as in Figure 2, it is obvious that a very small field flux will cause a high armature current and a resulting high armature flux. Furthermore, since the field flux has to build up to such a low value, and since the resistance and reactance of the short circuited armature are very low, full load current will be obtained in an exceptionally short time. If two poles and brushes are now added to this simple two pole generator, as in Figure 3, the short circuit axis armature flux will itself produce an emf. or voltage at these added brushes, which we will call the load axis. This is a so-called cross-axis excited generator.

If a load is connected to the load axis brushes, the load current itself will cause an armature flux which would oppose the initial field or control flux as in Figure 4. This would, of course, mean that the field flux would have to be strong enough to overpower this load axis armature flux. By using a series field through which the load current passes, it can be wound on the field poles in such a manner as to completely neutralize or compensate for the load axis flux. This series field is called the load compensating field and when used, the cross axis excited generator becomes an amplidyne. Thus, by the use of this field, the control field is only required to produce enough field flux and resulting emf. to overcome the electric resistance drop in the short circuited armature, and the time constant or rate of response is very fast.

It is extremely important to note that the number of ampere turns required to produce this field flux is only that required to force this small field flux across the small air gap and through the magnetic structure of the machine. Since the resistance of the short circuit axis and the air gap vary only slightly with various sizes of amplidyne generators, the required control or field flux likewise varies only slightly. This means that the control power required does not increase directly with the size of the amplidyne. From a practical standpoint, the control power required, because it is so small, may almost be considered a constant value irrespective of the size of amplidyne.

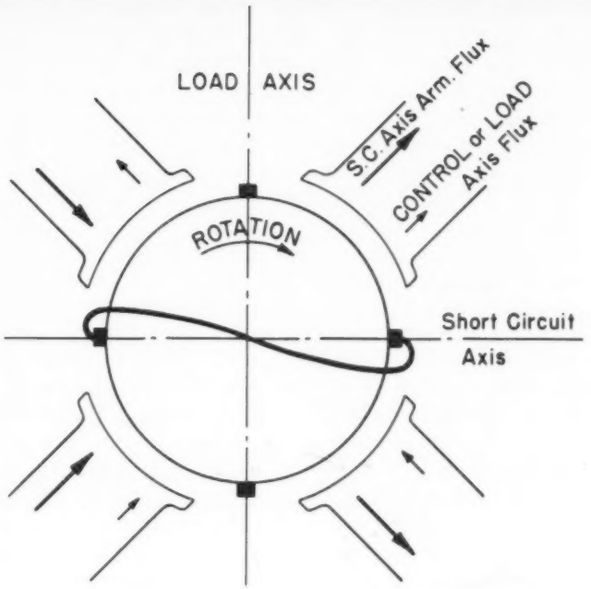


FIGURE 5—Actually, all four field poles of the amplidyne carry both short circuit axis flux and load axis flux.

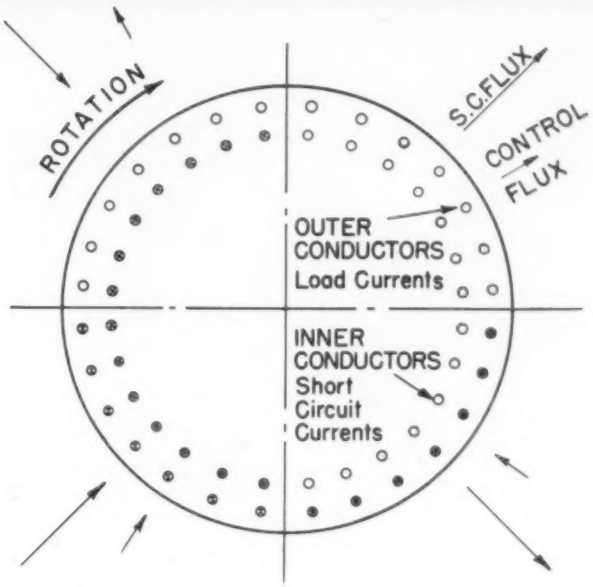


FIGURE 6—In the single set of armature conductors, load and short circuit axis currents act as if there were two armature windings.

The foregoing describes the fundamental principle upon which the amplidyne operates, and embodies all of the fundamental elements required, except those special modifications dictated by special conditions to be met. Any amplidyne, no matter how many fields or modifications it may have, may be explained in principle by the fundamental description shown in Figure 4.

From the fundamental description it would appear that since the amplidyne is really two machines combined into one, it would be roughly twice as large as a conventional machine of the same rating. However, this is far from being true.

First, let us examine the amplidyne from the standpoint of field flux. Actually all four field poles carry both short circuit axis flux and load axis flux, as shown in Figure 5, which also shows the actual relation between the brushes and the field poles. The brushes are midway between poles as in a conventional machine, so commutation is obtained at theoretical zero current. It will be noted that the two fluxes add in two diagonally opposite poles and subtract in the other two. As already described, the load axis or control field flux is very small as compared to the short circuit axis flux, and since the short circuit axis flux not only produces the output voltages, but is carried in all four poles, there is little difference in the size of the magnetic field structure between the amplidyne and the conventional machine of the same rating.

From the standpoint of armature design however, the story is somewhat different. Although there is only one set of armature conductors in the amplidyne, the load and short circuit axis currents act as if there were two armature windings, and Figure 6 is shown as though there were two windings in order to illustrate the resultant armature current around the armature. It will be noted that the resultant current is not uniform around the armature. Thus, since the short circuit axis and load axis currents may be somewhat equal to each other, the armature is electrically unbalanced. This, of course, causes armature saturation and copper losses to be somewhat larger than in conventional machines. However, from practical experience, a generalized statement can be made that the amplidyne is approximately 25 per cent larger than the conventional machine of the same rating.

This in itself is important because it means that from the standpoint of material alone, the amplidyne is more expensive than a single conventional machine. Thus, from the standpoint of economy, it would appear that the field of application of amplidyne should be confined to that of furnishing excitation only for larger machines, rather than being used as the main machine. In the case of very small machines this may, of course, not be true.

From the standpoint of design, this paper would not be complete unless at least two modifications of the fundamental design were described. It is sometimes desirable, from an economical design standpoint, to increase the amplification of an amplidyne by increasing the short circuit axis flux by other means than by increasing the short circuit axis current. This may be done in two ways (Figure 7): first, by adding a shunt field in the short circuit axis, but exciting this field by connecting it across the load axis brushes; second, by adding a series field which is excited by the armature current in the short circuit axis.

Figure 7 shows the probable possible number, and the relation of fields that might be used on an amplidyne, but all of them are seldom used on one machine. So far no machine has been built with both self-excited shunt and quadrature series field. Thus, an amplidyne has essentially only two fields: a control field for providing the control field flux, and a load compensating field. Of course, as many control fields which are on the same axis may be added as desired, depending upon the application. The possible uses of several control fields

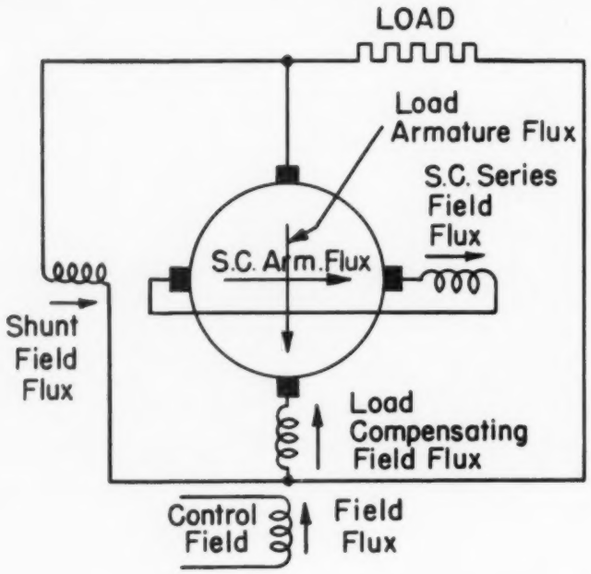


FIGURE 7—Schematic diagram showing modifications for reducing short circuit axis current and obtaining greater amplification from a given size machine.

will be brought out more clearly when the various applications are discussed. Either a self-excited shunt or a quadrature series field may be added in special cases to reduce the short circuit axis current. Interpole commutating field poles may be used as in a conventional machine to improve commutation where necessary. Thus, an amplidyne is no more complicated, and may be considered as merely a re-arranged conventional machine. It is just as reliable, and the same maintenance methods can be used on both. From a practical application standpoint, it may be considered as a standard shunt wound generator whose output voltage is dependent upon its control field flux and its inherent regulation.

CHARACTERISTICS

Let us now discuss the amplifying efficiency of the amplidyne. This is called the amplification factor and is defined as the load output watts divided by the input or control field watts. To speak of amplification without some qualification would be somewhat misleading because it can be anywhere between 100 and 100,000. First of all, amplification can be gained at the expense of time or rate of response. Thus, if amplification is carried too far in a particular machine, it may be too slow to be useful, especially in connection with the control of sudden changes in machines. Next, it depends upon the size of the amplidyne. As already pointed out, the required control watts do not increase as fast as the output watts would indicate, and therefore the amplification factor, other things being equal, is greater the larger the amplidyne. Furthermore, the amplification is greater at reduced loads for a given size of machine than at full load, because of saturation in the machine. From the designer's standpoint, therefore, the important thing is to know the amplification and rate of response required for an application, and an amplidyne can usually be built to meet the requirement. For practical purposes we may consider the amplification factor as being from 5000 to 10,000.

We have mentioned rate of response of the amplidyne briefly in the preceding paragraphs, and how it can be gained at the sacrifice of amplification or by operating at partial load. The rate of response decreases slightly as the size of machine increases. However, from a practical point of view the average rate of rise of voltage in an amplidyne may be considered in the neighborhood of 2000 volts per second. It should be carefully borne in mind that rate of response is dependent upon design details, and shorter time can be obtained by proper design where required. A typical rate of response is shown in Figure 8. Curve A shows a 60 cycle timing wave and the control field current. Curve B shows the short circuit axis current and Curve C shows the load or output voltage.

Note how nearly the output armature current and voltage are in synchronism with the control field current.

A very striking way to illustrate how nearly the load armature current and voltage follow the control field current, as well as the rate of response, is to apply an a-c. voltage to the control field as illustrated in Figure 9.

Thus in the amplidyne we have a reliable d-c. generator equivalent in principle to a simple shunt wound d-c. generator, but having a very high amplification factor, that is, requiring very low field control watts, and having a very fast rate of response to changes in the control field.

This would suggest in itself that the amplidyne could be used in place of a regulator and its conventional counter emf. exciter for the regulation of current, speed and voltage or a combination of these. This is true to a certain extent, but an understanding of how far this can be carried depends upon a close scrutiny of a comparison of the two.

A good regulator, whether controlling current, voltage or speed, must be sensitive, be fast or have a high rate of response, be stable, and be reliable. The amplidyne compares very favorably to a conventional regulator in all these requirements. However, it should be carefully noted that although the control field watts required to make it cover its entire range of output are very small on an amplidyne, this control power is still greater than that required to make a regulator open and close its contacts and, therefore, cover the entire output range. Where great accuracy is not required, the amplidyne can be used as a regulator itself, and the control system is almost identical to that of a regulator. Figure 10 shows the schematic or simplified elementary diagram comparing a conventional voltage regulator and the amplidyne voltage regulator. With the former a decrease in main generator voltage upsets the balance between the spring and the control winding, and the contacts of the regulator close, raising the voltage of the exciter and, thereby, that of the generator. On an increase in generator voltage the opposite happens. Likewise, with the amplidyne voltage regulator, a decrease in main generator voltage upsets the balance

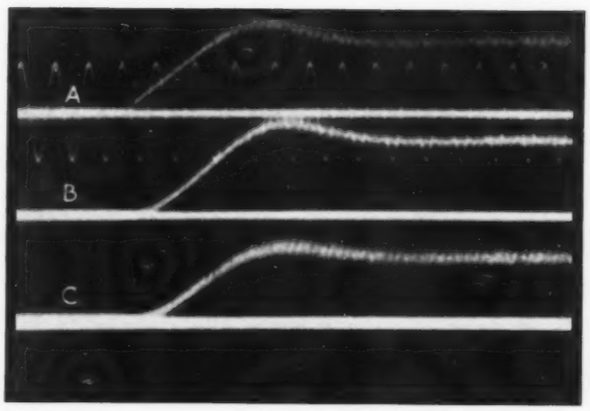


FIGURE 8—Oscillograph showing response of amplidyne to control transients. (a) Control field current, 60 cycle timing wave. (b) Short circuit axis current. (c) Load volts.

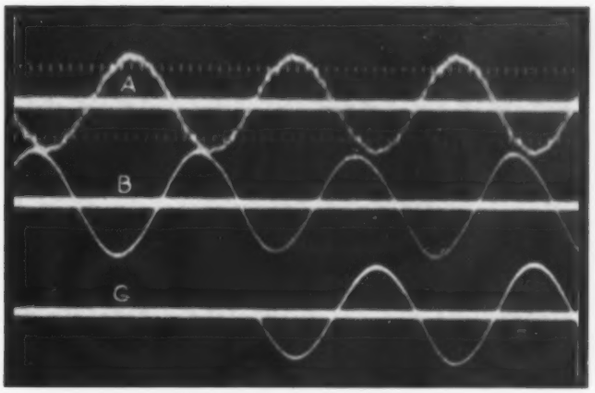
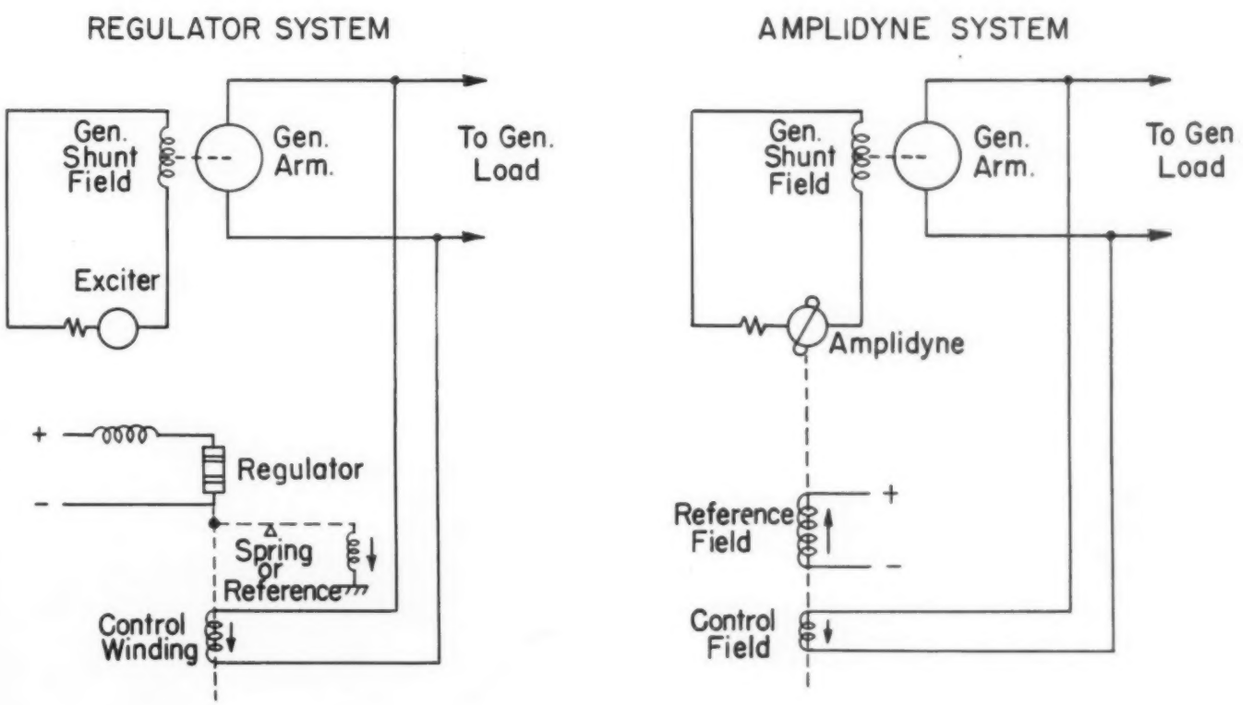


FIGURE 9—Response of amplidyne following a-c. applied to control field with load circuit closed. (a) Control field, 60 cycle timing wave. (b) Load volts. (c) Load current.

FIGURE 10—Schematic diagram showing the comparison between the conventional voltage regulator and an amplidyne used as a voltage regulator.



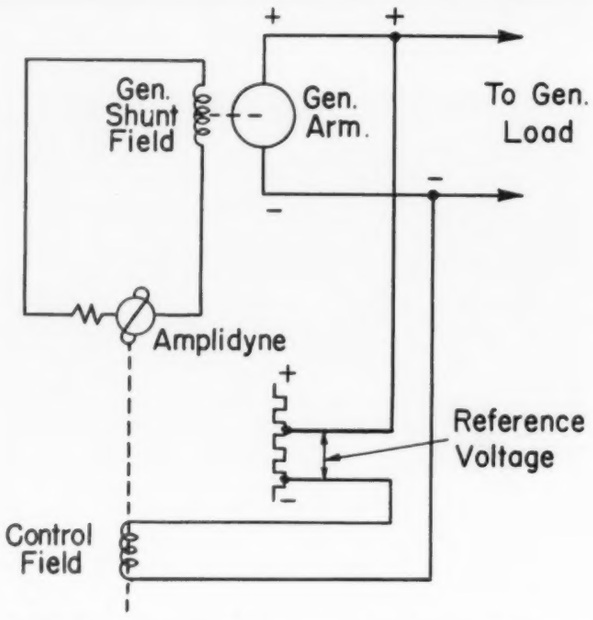


FIGURE 11—The amplidyne may also be applied as a voltage regulator using a reference voltage instead of a reference field.

between the reference field and the control field, which causes the raising of the amplidyne voltage and, thereby, that of the generator. On an increase in generator voltage the opposite happens. Note the almost duplicate connections and functions. Thus, the amplidyne is in effect a combined regulator and exciter, but of course somewhat less accurate.

In the example shown in Figure 10, there were two fields used to obtain the control indication of whether to raise or lower the amplidyne voltage. One is the control field, and this is balanced against the other, the reference field. In this case, if an accuracy of 5 per cent is required, 5 per cent change in the total current in the control field must supply enough excitation to the amplidyne to operate it over the required range, and the total current in the control field is, therefore, twenty times this value.

Another system could have been used requiring only one field on the amplidyne, as shown in Figure 11. Here it will be noted that instead of a reference field, a reference voltage is used. The action between the reference voltage and the generator voltage operates on the single control field in a manner exactly similar to the cause when the reference field and the control field were used. When the main generator voltage is low, the reference voltage is greater than the generator voltage, and a current is obtained in the control field in such a direction as to raise the amplidyne voltage and, thereby, the main generator voltage. Here, however, the control field carries only the current necessary to control the amplidyne through its required range, rather than twenty times this value. The various factors involved in a particular application determine which method should be used.

The amplidyne can be used as a speed regulator or a current regulator in a similar manner, by making the control field a function of speed, or current, respectively.

A number of typical installations have been made wherein the amplidyne has been used a sa regulator. A brief mention of some of these, will in all probability be interesting to you.

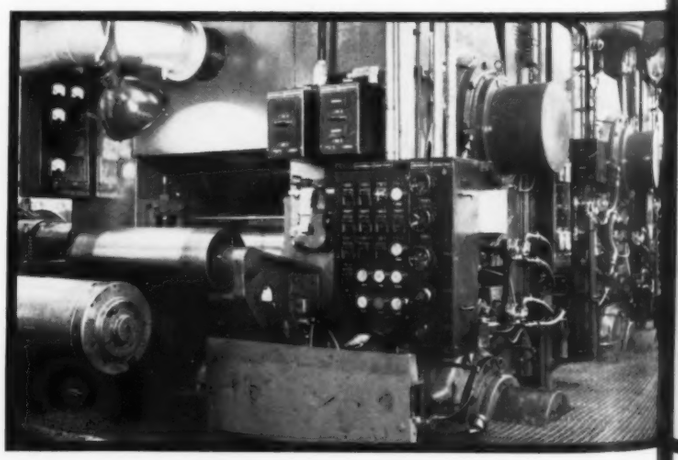
Several installations have been made of the amplidyne as a constant current regulator for tension reels, in connection with cold strip mills. One of these is on a tension reel which winds up the strip from a tinplate mill (Figure 12) which has a delivery speed of 2000 ft. per min., and which is accelerated from a low threading speed to maximum in approximately six seconds. This high rate of acceleration and the constancy with which tension must be maintained, even during acceleration, is a fairly difficult job. The amplidyne has given a most excellent account of itself on all of these installations.

Other installations have been made where the amplidyne has been used as a regulator for maintaining voltage on generators supplying cold strip mills. A wide range of regulation is required on such applications, because it is necessary not only to hold a constant high voltage at running speed, but also a constant low voltage at threading speed. Here again the amplidyne has performed admirably.

The greatest use of the amplidyne, in all probability, is that it offers a ready means for combining various functions in a complicated control system. Because of the very small number of ampere turns required in the control field, there is plenty of winding space available for adding a number of control fields. Thus, one may be a function of speed, and still another a function of current.

A distinction should be made between a regulator and a control system. The primary object of a regulator is to maintain a definite and accurate pre-set value on a dynamo electric machine such as speed, voltage or current. Control, on the other hand, is associated with changes; such as raising, lowering or reversing the voltage of a generator; accelerating, decelerating, reversing,

FIGURE 12—Cold strip tension reels may be equipped with amplidynes as a constant current regulator.



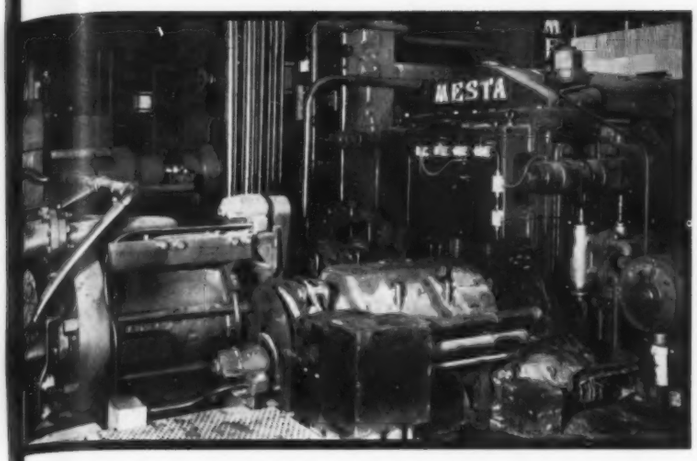


FIGURE 13—Control of the hot strip flying shear may be greatly simplified through the use of the amplidyne.

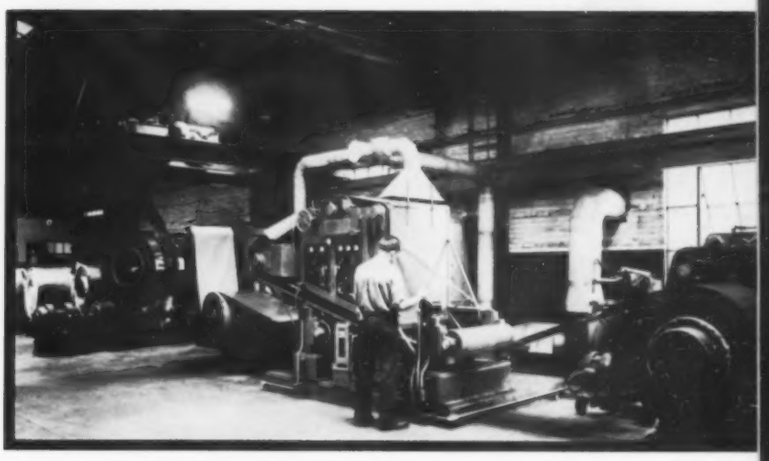


FIGURE 14—The amplidyne has been applied to strip grinders, where strip speed, and front and back tension must be controlled.

or stopping a motor—but to perform all of these functions within prescribed limits of voltage, current and speed.

So many of these functions are combined in some control cycles that the control apparatus, such as contactors, relays, rheostats, regulators and the like and their interlocked relations become exceedingly complicated. Take, for instance, a flying shear (Figure 13) following a hot strip mill. One operation of the shear is to crop the front end of a strip, in which case it is necessary to accelerate the shear by adjustable voltage control up to a speed slightly in excess of the delivery speed of the mill, crop the front end, stop the shear before it makes a second cut, reverse the shear and stop it very accurately ready for the next cut. If the shear makes a second cut while stopping, it means excess scrap, and cannot be tolerated. Another operation is to crop the tail end of the strip, in which case the shear must go through the same cycle. Here, however, it is important to accelerate the shear in less than one cut. The whole operation of cropping either front or tail must take place in three or four seconds, and very high accelerating and decelerating currents must be obtained. Furthermore, these high currents cannot be just high

FIGURE 15—Schematic diagram of a demonstration unit showing amplidyne used for current control.

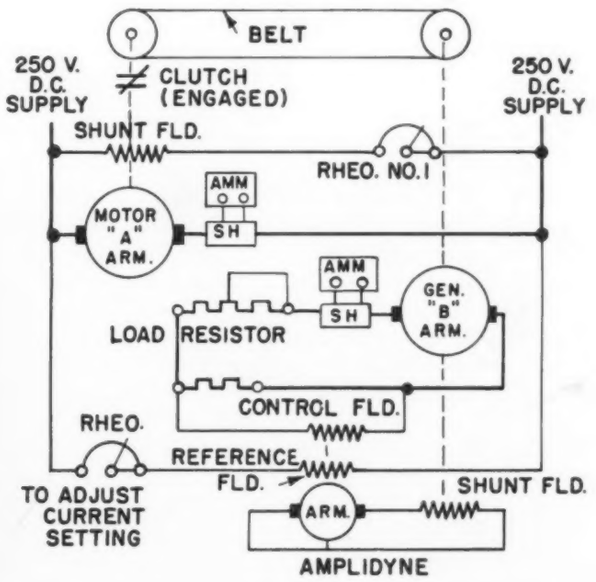
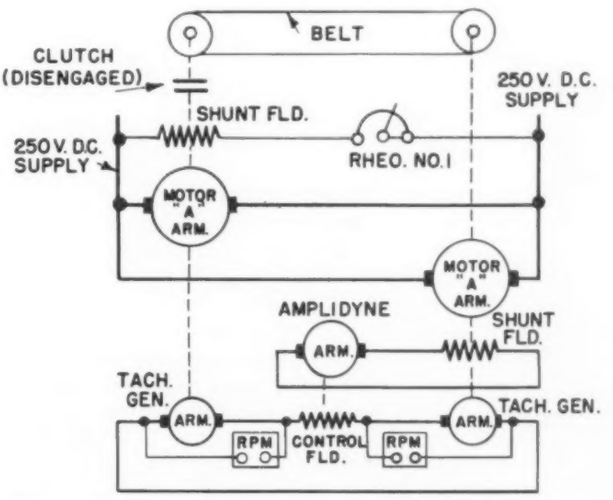


FIGURE 16—Schematic diagram of a demonstration unit showing amplidyne used for speed control.



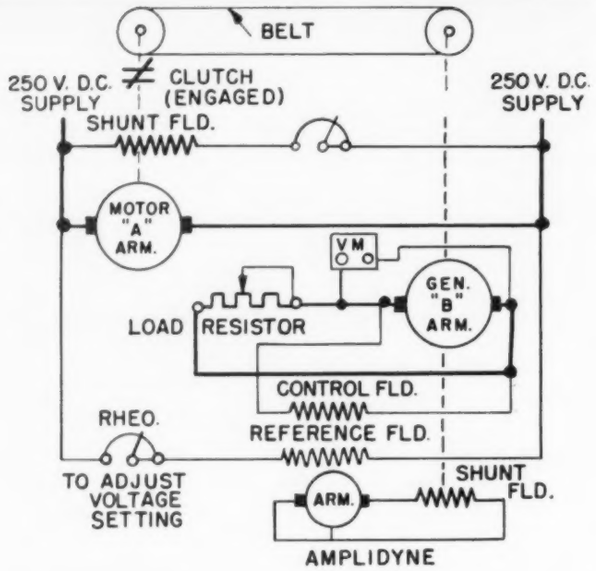


FIGURE 17—Schematic diagram of demonstration unit showing amplidyne used for voltage control.

peaks—they must be maintained over the entire cycle, so as to obtain the necessary high average torque. This means that very fast and fairly accurate current limit control must be obtained both during acceleration and deceleration. The reversing and stopping of the shear also requires accurate control.

Another operation is to crop the front end, and then shear the strip to length. In this case the shear must be accelerated just as rapidly as for cropping, and up to a speed as high as twice that of the strip. In addition, the shear is accelerated up to a speed where it engages one form or another of an adjustable gear, which is adjusted for the speed required for the length of cut desired. The shear cannot come up against this gear too hard, or breakage will result, and once against the gear a current regulator is used to hold a constant current input to the shear motors, so that the shear speed is determined by the gear unit at all times during cutting.

All this has been accomplished by using a complicated and special system of magnetic control relays and contactors, a current regulator, and conventional counter-emf. set.

However, an amplidyne has been applied to one of these shears and the entire control of current limit acceleration, current regulator operating during shearing, current limit deceleration, and reversing at a controlled rate of speed to insure accurate stopping, has been accomplished by one amplidyne and one control relay which, when energized, instigates the starting of the shear, and, when de-energized, instigates the stopping of the shear. Only three control fields are required on the amplidyne—one is a reference, one a function of relative speeds between the shear and the last stand of the hot strip mill, and the other a function of shear motor current. Here, in truth, is a real application of the amplidyne because of its simplicity, rate of response, accuracy and reliability.

A somewhat similar application has been made of the amplidyne for d-c. runout table control, in which case current limit control of acceleration and deceleration is provided, as well as voltage maintenance at running speed. In addition the same control provides a synchronous tie with mill speed, when desired.

Another application (Figure 14) is in connection with the strip grinder which has been successfully controlled by a single amplidyne. Here it is necessary to control both front and back tension on the winding and unwinding tension reels, as well as approximately constant strip speed.

The amplidyne has been applied to the control of a boring mill for the position setting of the tools, wherein it is merely necessary for the operator to set three dials, which are calibrated in feet, inches, and mils, respectively. In addition to providing a regulated feed speed over a 37 to 1 range, an accuracy of stopping to within 2 mils in 14 feet is obtained.

It is sometimes desirable from the standpoint of accuracy, sensitivity, and combined functions, to use a composing amplidyne. A composing amplidyne is one in which all the required functions are combined, and the output of this amplidyne is used to control a second amplidyne. The composing amplidyne is of course very small, say 100 to 300 watts, while the second amplidyne is the real power exciter. This gives a tremendous amplification and very fast response. Such an application is in connection with a tension reel, which requires accurate inertia compensation. The best method of accurately indicating rate of change is by means of a d-c. transformer with primary connected across a voltage proportional to the rate of acceleration, and therefore the secondary current is also proportional to the rate of acceleration. However, this secondary current is very small indeed, unless a tremendous transformer is used. This minute power can be amplified, however, by a small composing amplidyne, so that accurate inertia compensation can be obtained. In addition, on tension reels it is sometimes desirable to maintain a synchronous speed relation between the mill and empty reel until the reel is threaded, even though this be done during acceleration of the mill. After the reel is threaded, the control should no longer be a speed regulator, but a current regulator, so as to maintain constant tension on the strip. The composing amplidyne has performed both these tasks admirably.

Figure 15 shows the simplified connections of the amplidyne when used as a current regulator.

It will be noted that motor A drives generator B, which is loaded on a resistor. The amplidyne supplies excitation to generator B, and the control field of the amplidyne is connected across the load resistor. If the speed of generator B is changed by adjusting rheostat No. 1, the amplidyne will automatically control the excitation of the generator B so as to maintain approximately constant current in the load resistor.

Figure 16 shows the amplidyne used as a speed regulator. It will be noted that in order to demonstrate this operation, the clutch is disengaged, and motors A and B are mechanically separated. The control field of the amplidyne is now connected between the tachometers, which are driven by motors A and B, respectively. If the speed of A is changed by rheostat No. 1, the ampli-

dyne will now control the excitation of motor B so its speed will follow that of motor A.

Figure 17 illustrates the amplidyne when used to control voltage. Here it will be noted that motor A drives generator B, and the control field of the amplidyne is connected across the armature of generator B. If the speed of generator B is changed by adjusting rheostat No. 1, the amplidyne will automatically adjust the excitation of generator B so that approximately constant voltage is maintained on generator B.

A great deal has been said regarding the amplidyne as a regulator, but it should be clearly understood by all that it is not supposed to supersede or take the place of the conventional regulator. It should be considered as a helpmate of the regulator, and not an enemy. As a matter of fact, the amplidyne has actually been used as a composing means for a regulator on a tension reel where accurate inertia compensation is required. There have been some twenty-five applications of amplidynes made in steel mills as trial installations, or rather proving grounds. It is not the intent to go "hog wild" on applying the amplidyne. Where it is economically justified, can simplify the control, can give the desirable operating features not otherwise readily obtainable, or can improve performance, it should be used. However, it is not a cure-all, and should not be used wholesale.

One, and probably the most important possibility of the amplidyne, has been purposely omitted until last. The extremely low wattage required to control the field of the amplidyne makes it possible to use high vacuum, or so-called "hard" tubes as a controlling or composing means. The high vacuum tube is, as is generally known, a very dependable and inexpensive tube which may be purchased in radio supply and variety stores. Furthermore, its sensitivity and accuracy are well known. Thus, with these reliable and inexpensive tubes and the amplidyne, a combination can be obtained which is hard to beat for accuracy, rate of response, and dependability.

Such applications have already been made; for the speed control of a paper machine; for the registry control on a printing press where the indication is obtained from photo-electric tubes; and for ultra-accurate speed control of a flying shear in which no mechanical tie between the mill and shear is used.

In closing, it is important to note that there are already available vacuum tube amplifiers for indicating man's blood pressure, and phototubes for indicating his color. Therefore, we may not be far from our goal of controlling the speed of a 10,000 hp. motor in proportion to your superintendents blood pressure or the color of his face. At any rate we have a new and useful tool to help solve our perplexing application problems.

DISCUSSION

PRESENTED BY

JAMES FARRINGTON, *Electrical Superintendent,* Wheeling Steel Corporation, Steubenville, Ohio.

R. L. LIVINGSTON, Engineering Department, Carnegie-Illinois Steel Corporation, Irvin Works, Dravosburg, Pennsylvania.

C. L. McGRANAHAN, *Assistant General Superintendent,* Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

J. I. KASPARI, *Electrical Engineer,* Weirton Steel Company, Weirton, West Virginia.

F. MOHLER, *Steel Mill Engineer,* General Electric Company, Schenectady, New York.

B. J. BALLARD, *District Manager,* Reliance Electric and Engineering Company, Pittsburgh, Pennsylvania.

G. R. CARROLL, *Assistant Maintenance Superintendent,* Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania.

BRENT WILEY, *Managing Director,* Association of Iron and Steel Engineers, Pittsburgh, Pennsylvania.

A. D. McCREARY, *Electrical Construction Foreman,* Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

A. G. YOUNG, Research Laboratory, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

JAMES FARRINGTON: We put in an amplidyne in the latter part of 1939. I understand it is the first application of this kind that has been installed, and inasmuch as the mill was producing and we had to take it off over Saturday, we were worried as to whether it would work. In 60 hours, we had torn out our a-c. installation and installed d-c. and put it into service. We stopped worrying and have had practically no trouble since its installation. There are several men in our organization who will state they are more than pleased with it. We have been able to come to rest and get acceleration quicker than with frequency control, bringing the tables up to full speed in 3½ seconds. It has so far fulfilled all requirements, and I can safely say we feel it is here to stay. We are going to use it again on another application.

R. L. LIVINGSTON: Two amplidyne installations have been made at Irvin Works. One was added to the 5-stand tandem mill and the other to the hot mill shear. These installations were not contemplated in the original control scheme but added to secure more accurate and smoother control. In a year's service, maintenance has been low and operation of the equipment satisfactory.

C. L. McGRANAHAN: Our 54 in. 4-stand tandem mill producing tin plate had a speed originally of 905 ft. per min. which we increased to 1130 ft. per min. We then purchased a new gear and switched one of the others around, thereby increasing the speed to 1450 ft. per min. The regulation at this speed was nothing to boast about. We then purchased a new set of gears for the No. 4 stand and did some additional switching of gears and put on the amplidyne control and are now able to get a speed in excess of 1650 ft. per min. You would hardly recognize it as the original mill from the standpoint of acceleration and deceleration. It really appears to be a 200 per cent improvement over the old mill.

J. I. KASPARI: With a short circuit you will get a lot of current. How will the amplidyne circuit stay up when you are getting 250 volts out of the other pair of brushes?

F. MOHLER: The voltage on the brushes on the short circuit axis is probably 1 to 2 volts, not 250 volts. That is the whole secret of the amplidyne. It requires only a small amount of field flux to produce the small voltage required to produce full current in the short circuit axis and this current produces full flux and 250 volts on the load axis. Although there is only one set of conductors on the armature of an amplidyne, there are two isolated sets of brushes, one set of which commutates short circuit current and the other load axis current. The short circuit axis current is approximately equal to the load axis current but the voltage across the short circuit axis is negligible. Therefore, there is no more problem and no more current to commutate in the short circuit axis than in the load axis.

An amplidyne is similar to two machines in one. Consider the control field as the field on one low voltage high current exciter, the armature of which is connected to a low voltage high current field on a second exciter. The armature of this second exciter however is wound to give 250 volts. These two cascaded machines are similar to an amplidyne.

B. J. BALLARD: Mr. Mohler has described the amplidyne as an extremely sensitive device with great capabilities. Will the commercial shunt motor as we know it today be capable of taking full advantage of this performance, or will special consideration need be given to the magnetic properties of the field poles and frame of a motor responding to the amplidyne?

F. MOHLER: The commercial shunt motor as we know it today will, I believe, be capable of taking full advantage of the speed and sensitivity of the amplidyne. Of course, it is desirable to use low voltage shunt fields on certain applications so that the speed of response of the motor field is improved. This, however, is a minor modification of standard machines as we know them. Only in a rare and very special instance, none of which have come to my attention at present, would it be necessary to change the magnetic properties of the field poles or frame. Again for rapid accelerating and decelerating cycles, it is desirable to have low inertia motors capable of taking high peak loads, but these requirements are pretty well taken care of by the mill type motors which are in common use at present.

G. R. CARROLL: I would like to ask Mr. Mohler how accurate it will be, and if we can use an amplidyne on a small alternator.

F. MOHLER: The amplidyne has been applied to both small and large alternators and accuracies of 1 to 2 per cent obtained depending upon the conditions, such as rate and magnitude of the load application.

BRENT WILEY: To what extent is it necessary to include special features of design in the motors?

F. MOHLER: The mere fact that an amplidyne is used to control the excitation of a motor or generator does not mean that the machine to be controlled requires any more special features of design than if a regulator and counter emf. exciter were to be used to control it. To obtain the desired results it is sometimes necessary to use "fast" fields and low inertia machines when a regulator is used to control them and the same is true when an amplidyne is used to control them.

MEMBER: Did they use an oil gear on the flying shear?

F. MOHLER: No. The test I spoke of was without an oil gear. There was no mechanical tie whatever between mill and shear. We got the accuracy required with only an electrical tie between the mill and the shear.

G. R. CARROLL: Would you consider it as accurate to tie a roller leveler to a shear where we use oil gear or mechanical gear?

F. MOHLER: I assume you refer to a shear which follows a roller leveler for shearing tin plate strip into sheets, in which case the desired accuracy is in the order of $\frac{1}{32}$ in. in 30 in. or .1 per cent. believe that such high accuracy is almost beyond the accuracy of an electrical tie. I would like to tackle the job, but I would hate to guarantee the results.

C. L. MCGRANAHAN: What is the function of the large motor-generator set which consists of six or seven units?

F. MOHLER: There are six units on the motor-generator set referred to, consisting of four amplidynes, one conventional exciter and a squirrel cage driving motor. The conventional exciter which is a 15 kw. machine and one amplidyne, which is a small 125 watt machine, are used to control the fields of the two 1750 kw. generators which supply d-c. power to this mill. The amplidyne controls the excitation of the 15 kw. exciter, which in turn controls the excitation of the main generators. The amplidyne controls the acceleration and deceleration of the mill and provides voltage maintenance so that steady speeds for both threading and running are obtained.

One $7\frac{1}{2}$ kw. amplidyne provides constant current control for the 225 hp. reel motor and one 125 watt amplidyne provides accurate inertia compensation for reel drive and speed matching of the empty reel speed with the delivery speed of the mill.

The other 125 watt amplidyne provides inertia compensation for the four motors driving the four mill stands so that the motors accelerate and decelerate together with a minimum of tension fluctuation between stands.

A. D. MCCREARY: Will Mr. Mohler tell us what had to be done to the motors in this installation—particularly to the tension reel motor?

F. MOHLER: The only change made on the reel motor was to reconnect the standard 250 volt field in a series-parallel combination for 125 volts excitation. Then by inserting permanent resistance and using a maximum of approximately 450 volts, we obtained a fast field on the reel motor.

A. G. YOUNG: Does "hunting" go on indefinitely when the amplidyne is operating?

F. MOHLER: "Hunting" cannot be tolerated with an amplidyne any more than with a regulator. Anti-hunt features are readily applied so that no "hunting" is obtained.

CONTINUOUS ANNEALING

By R. J. WEAN, *President*

WEAN ENGINEERING COMPANY

WARREN, OHIO

Presented before

A. I. S. E. Birmingham District Section,

April 29, 1940

▲THE art of continuous annealing or heat treatment is used extensively in many industries, such as wire, copper, brass, and alloy metals. Continuous heat treatment of formed parts for tempering and strain relieving is also used in the automotive and aviation industries, but as yet little has been done in the field of continuous annealing of wide strip steel.

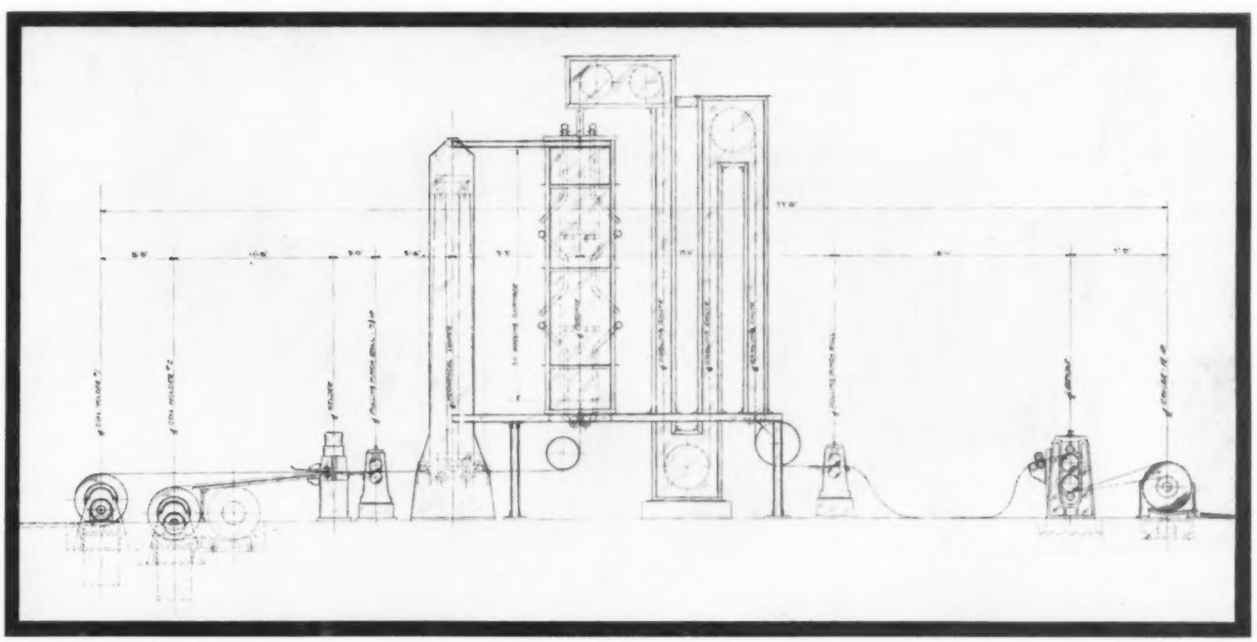
Some installations of long horizontal furnaces have been made, but the length of the furnace becomes prohibitive for a large rate of capacity, and the damage done to the surface of the material being annealed is a definite drawback to this type of construction. In addition to this, most furnaces of this type have been heated electrically, and the combination of all factors resulted in an excessive cost per ton for annealing.

Probably the best place to introduce satisfactory and low cost continuous annealing in the strip steel field is in the production of continuous cold reduced tin plate. While the principles advanced in this paper may be applied to heavier gauges and for other products, the equipment described is for the production of tin plate.

The present practice of coil annealing cold reduced tin plate leaves much to be desired from the standpoint of uniformity throughout the coil. Subsequent skin passing has a varied effect on the coil from end to end, due to the variations in the annealed coil. The natural result is that tin plate from the same coil will not perform uniformly in the dies and forming machines of the can producers.

In dealing with the process of annealing cold reduced

FIGURE 1—Sectional diagram showing the arrangement of the various equipment used in the continuous temper tower annealing unit.



tin plate, it is necessary to consider the combination of three operations. They are electrolytic cleaning, annealing, and skin passing, or temper cold rolling. The combined cost of these three operations at the present time most certainly must be very unsatisfactory to the executives in charge of the various mills, for this is one place where the cost of these operations far exceeds the cost of securing similar results in the old style tin mill.

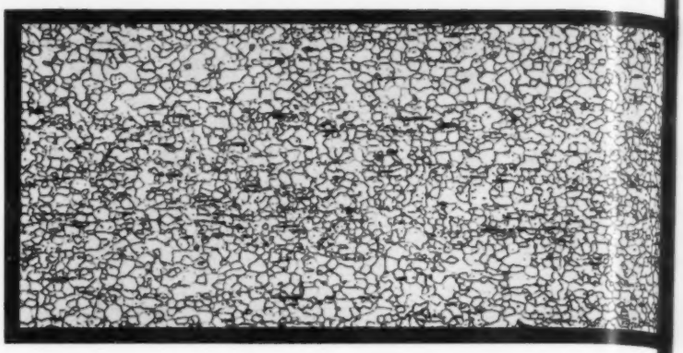
The introduction of a continuous temper tower annealing unit, as shown in Figure 1, should permit the production of tin plate for many uses at considerable economy. Tin plate produced in this manner would be subject to about 1300 degrees F. temperature, and would result in a small grain structure but one that should require less temper cold rolling and would be very satisfactory for many products. Electrolytic cleaning could be eliminated and the oil removed as part of the annealing operation. The use of gas as a fuel brings the cost of heating within a reasonable range, and is comparable with present methods of annealing. It is is true that cooperative effort is necessary between the producer and the consumer in order to develop the practice and treatments necessary under continuous annealing, but this should not be an insurmountable problem in view of the many advantages to be derived.

In describing the temper tower annealing furnace, it is necessary and desirable to describe the operations and equipment comprising the entire unit. Figure 1 shows the general arrangement of the temper tower annealing line. Coils can be charged at the entry end and discharged at the exit end without any change in the speed of the strip passing through the furnace. In addition, the arrangement of the line makes it possible to make an extra tight coil for temper rolling. The equipment will handle tin plate strip .0086 to .025 in. in thickness, and up to 38 in. in width, and has a speed range of from 75 to 300 ft. per min. When annealing 30 in. wide, .010 in. thick strip at a line speed of 200 ft. per min., the output will be approximately 12,000 lb. per hr.

On the entry end are two coil holders of the cone type, with hydraulically-operated cone heads and hydraulic lifts for elevating the coils into position to be clamped by the cones. The hydraulic controls are so arranged that the cone heads can be moved in and out either together or independently. Hydraulic power is obtained from an accumulator fed by a motor-driven oil pump. Each coil holder is equipped with an adjustable friction brake for providing back tension. The coils are delivered to the No. 1 coil holder on a ramp. A coil carriage, as indicated in Figure 1, is provided to permit entering a coil in the No. 2 coil holder while strip is being paid off from the No. 1 coil holder.

The next unit is a combination shear and pinch roll unit. This is a double-acting unit of the general design shown in Figure 1. The shear has a center knife blade in fixed position and independently operated shear knives both below and above the center knife. The pinch rolls are arranged with a center idler roll and an independently driven air-operated upper and lower roll.

The seam welder is a traveling head double roll unit arranged to make two parallel welds across the strip simultaneously. The carriage is equipped with a variable speed drive to give a welding speed of from 15 to 45 feet per minute. In addition, an ignition contactor



FIGURES 2 and 3—Representative cross section of black plate .012 in. thick, at 100 and 1000 magnifications respectively.

and special control is provided to permit making a series of intermittent welds rather than a continuous seam weld. The intermittent weld eliminates the tendency of very thin material to buckle at the weld during annealing.

The feeding pinch rolls serve to feed the material to the mechanical looper preceding the furnace. This looper is furnished on the charging side to permit an accumulation of slack so that strip movement through the furnace may be continued while joining strips in the welder.

Assume that the line is in operation with the strip being paid off from the No. 2 coil holder. A coil is then entered on the No. 1 coil holder and the end of the strip is fed by hand to the combination shear and pinch roll unit, where an air cylinder is operated to clamp the strip between the upper driven roll and the center idler roll. The leading end of the strip is then cropped through the operation of the upper shear blade and the upper pinch roll then feeds the end of the strip up to the welder. The above operations do not interfere with the passage of the strip from the No. 2 coil holder through the lower portion of the shear and pinch roll

unit, since the lower shear knife is open and the lower pinch roll is separated from the center idler roll.

When the end of the coil being paid off the No. 2 coil holder is about to be reached, the operator speeds up the feeding pinch rolls, thus permitting the counterweighted top rolls of the looper to move vertically upward, pulling the strip with them. At the top of the travel there is an accumulation of approximately 120 feet of strip. When the tail end of the coil reaches the up-cut shear, the feeding pinch rolls are then operated to bring the end of the coil into welding position, where it is welded to the leading end of the strip from the No. 1 coil holder.

As soon as the weld is completed, the air-operated upper pinch roll of the combination shear and pinch roll unit is raised free of the strip, the feeding pinch rolls are started, and normal operation is resumed. During this entire operation, the strip passes through the furnace at a constant rate, the furnace being fed from the accumulated slack on the mechanical looper.

The operation of the equipment, as described above, provides for exceedingly fast coil entry, since a new coil can be entered and the leading end sheared and brought into welding position while the previous coil is still being paid out.

The gas-fired temper tower strip annealing furnace with cooling tower is a vertical radiant tube annealing furnace which is approximately 30 ft. high, and is equipped with horizontal radiant tubes on each side of the strip. The tubes are of U-shaped design and are entered from opposite sides of the furnace, so as to give uniform temperature across the width of the strip. The normal operating temperature of the furnace is 1300 degrees F., with a maximum operating temperature of 1700 degrees F.

From the furnace, the strip passes through a six-pass vertical cooling tower, where the temperature is reduced to a maximum of 200 degrees F. The tower is constructed of water-jacketed, gas-tight chutes, the strip being cooled by forced convection. The heat from the forced convection passes is taken out by helical wound fin tubes.

Complete automatic temperature control is accomplished through the use of nine control zones. Each of eight of the control zones is equipped with an indicating controlling potentiometer pyrometer, which limits the gas through throttling type valves in accordance with the heat input required in the furnace for that zone. A recording controlling potentiometer pyrometer is used for the ninth zone.

The pulling pinch rolls are a duplicate of the feeding pinch rolls, and are placed in the line following the cooling tower to govern the movement of the strip through the furnace and cooling tower. Next follows a second mechanical looper, which is a duplicate of the looper described for the entry end of the line. The tension bridle has the function of maintaining sufficient back tension on the strip to permit the reel to wind a tight and uniform coil. A single-acting up-cut shear, designed for fast operation, is used for cutting out the weld from the strip.

The reel is of the collapsing head type with bronze reel head. It is driven from a separate d-c. motor through a totally enclosed gear reduction unit, the slow speed shaft of which is the spindle for the reel head. The head is collapsed by means of toggles, collapsing being accomplished by a foot-operated brake and slightly reversing the main drive motor. A stripping device, consisting of a car running on rails and actuated by an air cylinder, is provided for removing coils from the reel. A hydraulic elevated platform is mounted on the car for supporting the coil during the stripping operation. For fast entry of the leading end of a strip on the reel, an automatic belt wrapper is provided. This unit is brought into position by an air-operated cylinder, and is removed after the coil is started, so as to permit stripping the coil.

At such time as it is necessary to cut out a weld, the reel and tension bridle are stopped and the weld is cut out by operating the up-cut shear. The tail end of the strip is then quickly wound on the reel, the reel is collapsed, and the coil is quickly stripped from the reel head by means of the coil car and hydraulic lift.

FIGURES 4 and 5—Views of opposite sides of tinplate (carrying a coating of 1.33 lb. per base box), after being subjected to ferroxyl pinhole tests.

As soon as the coil clears the end of the reel, the belt wrapper is moved into position around the drum. The tension bridle is then operated to feed the leading end of the strip up to the reel, where it is quickly and automatically entered by means of the belt wrapper. The line is then ready for normal operation.

While the above operation is being performed, the pulling pinch rolls pull the strip through the temper tower furnace at a normal rate of speed, and the accumulated slack is absorbed by the mechanical looper. This slack is taken up by a slightly increased speed of coiling.

Other exit end arrangements can be devised, but the one described would seem to be the preferred method.

A lineal speed range through the line of 75 to 300 feet per minute will be accomplished by d-c. motors with Ward-Leonard control. The power for the motors for driving the feeding and pulling pinch rolls will be obtained from a separate generator, the speeds of the motors being varied by varying the voltage supplied by the generator. In addition, the motor for driving the feeding pinch rolls will have a 2 to 1 speed range by field control, so as to permit the necessary speeding up for accumulating slack in the mechanical looper preparatory to the welding operation. The motors for driving the tension bridle and the reel will obtain their power from a second generator, the speed of the reel motor being varied by varying the voltage supplied by the generator. In addition, the reel motor will be equipped with a 3 to 1 speed adjustment by field control to take care of build-up in coil diameter. This is accomplished by a rider roll rheostat operating on the field of the reel motor. The motor on the tension bridle acts as a drag generator and feeds power back into the system in proportion to the back tension which it is exerting. Coordination between the coiling speed and the speed of the strip through the furnace is manually controlled by means of scales marked on the rheostats.

Control equipment includes main control panel, operating control panels at the entry and exit ends of the line, and accessory control equipment for separate mounting, including rider roll rheostat, limit switches, and brakes. D-c. voltage must be provided for separate excitation for motor and generator field and control circuits. This may be of 230 volt or 125 volt d-c.

The operating cost of this unit should be approximately as follows:

Two operators are required and assuming a rate of 72 cents per hour and a production of 6 tons per hour..	$0.24 per ton
Fuel cost, using 1000 Btu. gas and 800,000 Btu. per ton with gas at 45 cents per 1000 cu. ft.	.36 per ton
Power allowance	.05 per ton
Total	$0.65 per ton

Feeling that there would be general interest in laboratory results from material that had been produced by this method, the following data is offered for your consideration.

Figure 2 is a representative cross section of black plate 0.012 in. in thickness, magnification x 100. Figure 3 shows a specimen of the same plate as in Figure 2, but at a magnification of x 1000. Competent opinion indicates that the uniform, small grain structure shown is quite satisfactory for many products made from tin plate.

In order to show the results of cleaning in the furnace and elimination of electrolytic cleaning, tin plate samples were subjected to ferroxyl pinhole tests. Figures 4 and 5 show the results on the two sides of the plate. The coating on this plate was 1.33 lb. per base box, and the patterns indicate a porosity approximately that of regular coke plate of equal coating. The chemical composition of the samples was as follows:

Material	C	Mn	P	S	Si	Cu	Cr	Ni
Black plate..	0.06	0.38	0.009	0.024	0.004	0.06	0.024	0.020
Tin plate....	.10	.49	.009	.025	.005	.10	.019	.026

In general, the plate tested appears to be fairly stiff, which may be advantageous although the good elongation results indicate drawability, but uneven forming might result from the stiffness and possibly an abnormal development of stretcher strains due to the fine grain structure. However, such plate would undoubtedly be suitable for most applications where extreme deep drawing quality is not required.

Both longitudinal and transverse tensile specimens were prepared and are designated as "L" and "T" in the table. The samples were taken from the mid-sections of the sheets.

The results of the black plate and tin plate tests support the assertions made earlier in this paper that satisfactory material can be produced in the temper tower annealing line.

In closing, I wish to summarize the advantages to be derived from its use:

1. Uniform anneal.
2. Uniform surface.
3. Better metallurgical control.
4. Bright anneal.
5. Elimination of conventional electrolytic cleaning.
6. Less cold rolling of product required for tempering.
7. Faster operation. A 6,000 lb. coil can be annealed in a half hour, whereas with conventional annealing 36 hours or more would be required.
8. Accurate control of temper desired.

TABLE I

Tensile Properties, Hardness, and Olsen Ductility

Material	Specimen	Elongation per cent in 2 in.	Lower yield strength (lb. sq. in.)	Ultimate strength (lb. sq. in.)	Hardness Rockwell 30 T
Black plate..	L	29.3	39,700	55,050	58
	T	27.8	39,000	53,100	
Tin plate....	L	17.8	58,800	61,150	66
	T	24.8	60,000	61,700	

Material	Pressure, total lb.	Deformation in in.
Black plate	1025	0.298
Tin plate	934	0.282

ABSTRACTS OF PAPERS

TO BE PRESENTED BEFORE A. I. S. E. CONVENTION, HOTEL STEVENS, CHICAGO, ILLINOIS
SEPTEMBER 24, 25, 26, 27, 1040

WELDED CONSTRUCTION OF BLAST FURNACE STOVES

By H. C. Boardman

This paper is written to acquaint engineers, operators and executives in the steel industry who are not familiar with welding with the details of fabrication and erection of welded blast furnace stoves and with the advantages of welded over riveted construction.

Emphasis is placed on the similarity of welded blast furnace stove shells and the welded shells of gas, water and oil tanks, to all of which welding has been applied successfully for many years. A brief history of tank welding is used to introduce the idea of welding the shells of blast furnace stoves, and then a discussion of welding as applied to tanks is used to present the fundamentals of manual electric arc welding and the subjects of shielded-arc electrodes, stress-relieving, qualification tests, relatively adverse working conditions for field welding operators, welding grooves and their preparation, dishing, rolling, flame machining, manipulation of electrode during welding, joint efficiencies and design stresses, cold weather welding, assembly methods, welding sequence, and weld inspection (radiographing, trepanning and magnafluxing).

Finally, to fix this presentation, there is given a description of two welded blast furnace stoves recently completed for the Carnegie-Illinois Steel Corporation at Youngstown, Ohio.

RELATION OF FLAME CHARACTERISTICS TO OPEN HEARTH OPERATION

By A. J. Fisher

The paper discusses the effects and advantages of flame control in open hearth furnaces.

The first part of the paper shows the practice that may be gained by stabilizing the open hearth operation by means of improved furnace design, auxiliary equipment, instrumentation, and control. The necessity of having this work done before flame control can be accomplished is shown.

The second part of the paper deals with flame temperatures and their complementary items. The effect of different kinds of atomization is shown. The relation of actual flame temperatures and flame luminosity to the rate of heat transfer to the bath is discussed at length. The factors involved in the control of this relation are shown and means of controlling same are discussed.

This paper should be of paramount interest to all open hearth operators as it deals openly with the elusive forces that all operating men know about and respect; namely, flame temperature and flame luminosity.

A SURVEY OF OPEN HEARTH FURNACE DESIGN

By W. C. Buell, Jr.

This paper deals with the problems of furnace sizes and productive rates and with the effects of design and of the use of different charges and fuels on operations. The modification in productive rates when making different grades of steels is briefly touched upon. The data upon which the paper is based is largely drawn from answers to a questionnaire sent to about forty plants after the invitation to present the paper was received and is therefore entirely up-to-date.

The paper holds that a shallow bath will produce steel more rapidly than a deep bath against a unit of productive performance, and that as furnaces of smaller capacity may be expected to have less bath depth than the larger furnace, the smaller furnace is the relatively faster producing unit. Fairly conclusive data is offered in support of this conclusion.

In high iron practice silicon is stated to be the metalloid, the oxidation and fluxing of which is most costly to operation. A method of controlling silicon in the metal delivered to the open hearth is suggested.

Shops with six or seven furnace units are claimed to be more rapid producers than those with ten or more units in line.

Steel making practice is stated to be made up of four principal and several subsidiary items covering furnaces, plant, charge and personnel, and if any of these factors fail to meet the present day concept of the best, the overall results of any plant will fall into mediocrity.

An interesting numerical constant which developed incidental to this study is found in the value "215." By dividing this constant by the time of a heat in hours, the answer must always be "net tons of steel made per 1000 cu. ft. of metal in the bath per hour." It offers a simple means of comparing with exactitude any phase of open-hearth operation, and should find wide general use.

MANUFACTURE AND COMPOSITION OF GREASE LUBRICANTS

By Thomas Lennox

It is the purpose of this paper to present a general picture of the present day grease plant and its products through discussion of the improved types of equipment, general grease manufacture and classified composition of the various types of grease.

In describing the various raw materials, the different classes of greases and their composition and manufacture, it is believed that the limitations imposed on each type, along with its advantages, may be more generally known. A discussion of the different raw materials used in the manufacture, the definition and explanation of such terms as soaps, solid and semi-solid

lubricants, the method by which the gradings of greases are arrived at, and some of the factors governing the selection of the proper type of grease, based on the application, all tend to cast a little more light on the subject.

The description of the equipment used in the grease industry and the discussion of the procedure used in the manufacture of the greases most generally known are presented in a non-technical manner in order to supplement the above. Finally, a more detailed treatment of the composition of the most widely used greases, discussed by types, tends to eliminate confusion often encountered in discussing lubricating greases containing different soaps as their thickening agents.

COMPOSITION BEARINGS FOR ROLL NECKS

By H. R. Gilchrist

Until a few years ago, the conventional bronze, babbitt, or bronze-babbitt bearings for rolling mills, with the lubricant packed against the roll neck in the form of heavy grease, were accepted as regular practice. Due to the failure of this grease to stay on the neck, and lubricate properly, frictional losses were high, bearing life was short, roll necks were scored, and much grease was wasted.

The necessity of holding close gauge tolerances, coupled with the foregoing faults of the old bearings, focused attention strongly on the bearing problem. One of the most important results of the study of this problem has been the development and successful application of composition bearings to roll necks, eliminating almost entirely the objections found in the use of the old metal bearings.

Composition bearings are now available in a wide variety of shapes and sizes, for almost every conceivable application. It must be remembered, however, that good roll necks are of the utmost importance for the successful use of composition bearings. Furthermore, a hold-down or separator should be provided to hold the top and bottom rolls in place, rather than depend on the roll weight alone.

Composition bearings require enough water to keep the roll neck cool, but it need not be supplied at very high pressure. Various methods of applying the water are discussed in the paper, together with the method of treating the water if it contains more than 10 parts of acid per million. A method for getting more life out of worn bearings is also presented.

This paper further discusses the necessity of proper roll alignment and of prevention of scale entry into the bearing, and a method of testing the bearing material.

Typical curves are presented showing wear on six different composition bearing materials under various methods and degrees of loading. Additional charts show the reductions in power consumption, bearing cost, and lubricant cost of a mill before and after the application of composition bearings.

DESIGN AND OPERATION OF CONTINUOUS BUTT WELD PIPE MILLS

By J. H. Loux and E. T. Trebilcock

The first continuous buttweld pipe mill cost $525.00, and its maximum pipe size was ⅛ in. In 1921 and 1922 continuously buttwelded pipe began to be made on a production basis. Between the spring of 1938 and the fall of 1940, ten large mills have been put in operation in the United States and Canada. Three of these mills are capable of making 4-in. diameter pipe.

The principle of operation is to pull flat skelp through a heating furnace and a forming and welding mill continuously, and to cause it to weld by its own heat, after which it is sawed in lengths, descaled, sized, and cooled.

Improvements and developments include such items as automatic uncoiling boxes in place of simple reel posts which support the skelp while it is being uncoiled. On all 4-in. mills, this automatic uncoiler is built as an integral part of the roller leveler.

The heating furnaces for the 4 in. mills have been increased in size and capacity to handle the greater production of the larger size pipe. Three of the recently installed ten furnaces were designed to operate on natural gas, six on coke oven gas, and one on bunker C oil. All furnaces use preheated air.

The original forming and welding mills used one main drive motor, with partially open gear drives. Later mills were made 50 per cent heavier and included centralized lubricating systems with gears enclosed. All 4 in. mills, however, were designed with a separate drive motor for each pair of rolls. Each motor is equipped with a separate variable speed control and with an ammeter for indicating motor load.

The hot saw, which has often proved to be a bottleneck in the production of continuously buttwelded pipe, has been redesigned to a point where pipe cutting tolerance does not exceed plus or minus ⅛ in.

Descaling and sizing mills have followed substantially the trend of the forming and welding mills, and all 4 in. mills use a separate drive motor for each pair of rolls.

Originally, a separate furnace threading needle was required for each size of pipe manufactured. It was later found that one small needle could be used for all sizes of pipe, and a still further development in threading eliminates the necessity for the pipe needle altogether.

BUILDING UP AND HARD SURFACING

By L. Ames

In recent years, the steel industry has made every effort to cut operating costs, while maintaining production schedules and turning out quality products. Substantial economies have been realized by building-up and hard-facing worn parts. Three major processes are

employed for this important phase of welding: oxyacetylene, metallic arc and carbon arc. The oxyacetylene process is generally used for cast iron welding, bronze welding and non-ferrous metal welding. With the torch, the operator has accurate control of the rate of metal deposit, thickness and smoothness of the overlay. The metallic arc process is the one most widely employed in steel plants. The speed of metal deposit, economy of operation, wide selection of electrode analysis and flexibility are all in its favor. It permits welding in confined areas and on heavy machine sections. The carbon arc is used to a lesser degree, but is preferred for filling sand holes in steel castings, building-up badly worn cast iron wobbler ends, copper welding of heavy sections, and similar applications.

A good rule to follow in building-up is to use a welding rod of an analysis similar to that of the base metal. It is now possible to obtain suitable rod material to meet almost any requirement. The conditions under which the part works should be thoroughly studied before a build-up material is selected.

Reclaiming worn piston heads by bronze welding, building-up worn or broken gear teeth, reclaiming of cast iron, steel and bronze mill guides, by building-up or hard-facing, building-up and hard-facing worn shafts and reclaiming worn wobblers, rolls and roll necks are good examples of steel mill applications of the welding processes. In many plants, track maintenance costs and derailments have been materially reduced by building-up rail ends, frogs and switch points in yard track. This welding is usually done with the oxyacetylene torch. In rail welding, a welding rod with a deposit that will resist impact and abrasion and which will not spall is selected. Frogs can be welded in place, but it is preferable to perform this operation in the shop. Manganese frogs are built-up with metallic arc process.

Both building-up and hard-facing are playing an increasingly important part in reducing costs in the steel industry. In the face of the present emergency, with the attendant difficulty of procuring new replacement parts, the value of reclaiming and prolonging the life of worn equipment cannot be overemphasized.

MODERN ELECTRIC FURNACE DESIGN AND PRACTICE

By H. F. Walther

Within the last three years the electric melting furnace has assumed a more prominent place in modern steel production than ever before. The demand for closer control in chemical analysis and physical requirements by the automotive and aircraft industries have played no small part in exerting pressure to expand the industry. Constantly, new uses are being found for the various types of stainless steels and many other complex types, the manufacture of which are possible only in the electric furnace. With the building of larger melting units the electric arc furnace has to a great extent been competing with the open hearth process on a quality basis, though not on a production cost basis, in melting much steel in the simpler alloy types.

In investigating furnace construction and melting practices in the various plants, one is amazed at the various uses to which this most versatile of melting units may be applied. It may also be said that melting technique in producing the same types of steel differs somewhat with the various operators, in accordance with their concepts of the metallurgy of the process.

The electric melting furnace may be divided into three main classes: direct arc, indirect arc and induction. Each type has its place in ferrous or non-ferrous production and the installations of all three are constantly growing in number.

It is the purpose of this paper to discuss the direct arc furnace and related practices, since in this type the greater tonnage of metal is being produced. Due to recent developments in furnace design and operation it is apparent that this expanding industry should be of intense interest to all engineers and metallurgists.

To those farsighted pioneers who invested their capital and talent in developing the electric furnace process, tribute must be paid. Their efforts have been justified, in that we find the state of the industry at the present time of paramount importance and commanding the attention of all manufacturers of quality steel.

APPLICATION AND CARE OF BEARINGS IN STEEL PLANT AUXILIARIES

By F. L. Gray

The application and care of bearings in steel plant auxiliaries is a topic that has received much attention from the lubrication view point in the past decade. On recent equipment the design engineer has indicated a thorough grasp of lubricating requirements and has simplified the operator's problems by the application of improved bearings and provisions for proper care and maintenance. The improved design has shown, by contrast with older type of equipment, what is possible in the way of reduced maintenance and cleaner, safer, and more economical operation. It is a challenge to improve lubrication of the older auxiliary bearing design.

In the lubrication of older steel mill equipment, black oil, the cheapest and least refined of the lubricants, attained universal use. As a lubricant it did its job remarkably well. Pinion, line and drive shaft, and table roll bearings were supplied by gravity flow from a container or through an oil soaked mass of cotton waste. Excess oil found its way to the floor, sewer, or into the concrete foundations. It has been our opportunity to clean up, and in most cases, to materially improve lubrication by the installation of pressure grease systems.

Roller bearing temperatures of 450 degrees F. on runout and transfer tables are no longer a maintenance problem. Grease manufacturers have successfully designed a product to meet these temperatures without wastage or excessive usage.

More attention is now being given to the prevention of oil drippage from crane journal bearings of the oil cellar type. The presence of oil under crane runways is not only unsightly and hazardous but also causes damage to products temporarily placed underneath. The extended use of oxygen piping systems has required the elimination of the oil drippage nuisance. These stations, of necessity, must be placed along crane travel ways.

The rapid oxidation of oils or greases in the presence of oxygen under pressure is well known and safety measures must be taken to prevent this condition.

As an auxiliary within the steel plant, the internal combustion engine using blast furnace gas as a fuel offers the lubrication engineer a challenge in the maintenance of the circulating oil supplied to the bearings and bearing surfaces. In gas engine operation the large amount of make-up oil and the large amount of labor and material necessary to keep the oil and the system in an operating condition are factors that increase operating costs. The present methods of treating the oil in service or replacing it with the new oil after the danger point has been reached, are not conducive to economical results. The cause and not the effect must be treated to modernize this condition.

For too long a period, the cost of lubrication per ton of steel has included the total cost of the oils and greases consumed. A change to a better quality oil was represented by an increase in the cost per ton of the product for lubricating purposes. Mill delays and repairs as the result of the failure of lubricated parts are now corrected by improved lubrication methods, with the increased cost balanced against the saving in maintenance. No matter how ancient the practice or obsolete the equipment, it is the responsibility of the lubrication engineer to recommend the lubrication that will best reduce the cost of maintenance and provide a safer and cleaner place in which to work.

To this end it has been our aim to displace the use of inferior lubricants and at the same time reduce the need for the oil can or grease bucket, thereby eliminating waste, reducing maintenance, building up efficiency, and contributing to reduction of the working hazards of the individual.

DIESEL SHIFTING EQUIPMENT IN THE STEEL PLANT

By E. M. Smith

Records show that the first diesel switching locomotives entered service in 1925, and in the span of 15 years, the number had grown to 674. It is believed that the close of 1940 will see not less than 1000 diesel locomotives engaged in switching, of which perhaps 150 are in the steel industry.

Sizes of diesel switching locomotives have been rather generally standardized at 300 hp., and 600 hp., and 1000 hp. This standardization has resulted in economic benefit to the users. Characteristics of the locomotives render them very well adapted for switching service. All of the locomotive weight is carried on the driving wheels, and full rated power is delivered at all speeds, including the low switching speeds of six or seven miles per hour.

Diesel switchers show a higher availability than steam locomotives, being normally available for service for 8000 hours of work per year, and carrying sufficient fuel for four or five full days of operation. They offer great flexibility and high efficiency, as well as unusual safety.

The design and construction of the diesel locomotive make for low maintenance costs. Experience indicates that, ordinarily, the average hourly repair expense should not be more than 50 per cent of that on steam locomotives of corresponding age. Lower track wear and maintenance is also indicated.

A study of costs of diesel vs. steam switching shows a cost of $1.82 per hour for the former, against $4.07 per hour for the latter. The breakdown of these costs shows the diesel to have the advantage in each item of operating expense except lubrication. The savings in this case show the possibility of liquidating the investment cost in about five years. In addition, switching work may be handled in less hours and with less locomotive units.

This paper further lists typical data on dimensions and design of three standard sizes of diesel switching locomotives.

HOT STRIP COILERS AND THEIR DRIVES

By R. A. Geuder

Probably the first hot strip coiler in America went into operation in 1918. Early installations were not particularly influenced by requirements for wide strip, and therefore did not present the multitude of problems inherent in the modern mills. The advent of the wide strip mill and the marked increase in flat-rolled production have brought the coiler into a position of prime importance. By far the greater portion of flat-rolled product is produced in coil form, due to the economies offered in subsequent processing.

The hot strip coiler has steadily been improved and modified until there are probably 100 hot strip coilers in operation all over the country, some handling steel up to 100 in. in width, and some at top speeds up to 4000 ft. per min. Material ranging from No. 20 gauge up to 3/16 in. can be successfully coiled hot.

In the demand for hot strip in coil form, there has naturally arisen certain requirements and economics which influence the type of coiler that may be applied. Progress throughout the years has also done much to influence the kind of coiler that might be used and the practical results that have been obtained. Several types of coilers are available, and each has its own particular reason for existence, and probably each has a logical application. There are upcoilers, which as the name implies, coil the strip above the line of flow of the material. There are pin or paddle type coilers, which wrap up the strip on a series of pins and is usually operated as a vertical coiler. There are downcoilers, which are subdivided into two groups: the internal expanding type and the mandrel type.

In this paper, these various types of coilers are illustrated and discussed. It is not the purpose to advocate the use of any particular type, but rather to present the facts of general usage in the industry.

POWER REQUIREMENTS FOR HOT STRIP MILLS

By W. M. Ballenger and T. R. Rhea

It is the purpose of this paper to present to the Association power consumption data collected on a large number of modern high speed continuous hot strip mills. Most of the mills considered are of the con-

ventional arrangement; that is, four roughing stands with or without anti-friction bearings and six finishing stands with anti-friction bearings. The mill sizes range from 44 in. to 98 in. wide and the speeds vary from 1200 to 2000 ft. per min. No significant difference in power consumption, as expressed in kwh. per ton, was noted between mills with roller bearings and those equipped with oil sleeve bearings and no appreciable difference was noted between mills operating within the above limits of speed.

Up-to-date power curves for mild steel, common alloys, and stainless steel are included. These curves indicate that the common alloys require approximately 25 per cent, and stainless 100 per cent, more energy per net ton than does mild steel.

The procedure followed in obtaining the necessary data for plotting the curves is outlined. With accurate power curves available the horsepower requirements for any mill and for any rolling schedule may be easily calculated and the methods used for these determinations are included.

Very little information has been published on the average energy input in kwh. per net ton on main drives and auxiliaries. A considerable amount of data on a number of modern mills has been accumulated and analyzed. It is interesting to note that the energy consumption in kwh. per net ton of the main drives is fairly constant during months of light, medium, or heavy production. This indicates that the rolling schedules are sufficiently well planned so that a variation of almost 300 per cent in monthly production has little effect upon the kwh. per ton. It is also interesting to note that the energy consumption per ton of the main drives is remarkably consistent regardless of size or delivery speed of the mills considered.

A general average, called a "national average," of kwh. per ton of main drives and auxiliaries is presented. Each operating engineer may compare his own figures with the "national average." Several suggestions for saving small amounts of power are mentioned.

The power curves may be used to calculate the energy consumption in kwh. per ton for any specific or average rolling schedule. In making these calculations one is impressed by the tremendous effect of main drive idling losses upon the total energy consumption due to the low "time factor," or ratio of actual rolling rate to theoretical rolling rate. One can also appreciate from these calculations how the energy consumption may go up during periods of light rolling if the mill is not scheduled to maintain a high "tons per hour" rolling rate.

EFFECT OF PIT OPERATION ON STEEL CONDITIONING

By Charles Labeka

An attempt has been made to present a few of the effects that soaking pit operation has upon steel conditioning. These facts are not theoretical but are based upon several years of observation of mill practices and ultimate yields and are supplemented wherever possible by actual data.

It was found that minimum steel conditioning could only be obtained by very rigid control in both the open-hearth and blooming mill departments. Since the condition of the steel ingot when it is charged into the soaking pits has a great influence upon subsequent surface defects, a few of the controllable conditions conducive to good surface requirements are presented.

In the manufacture of capped steels, some heats are thin skinned. This condition is common in an analysis range of .15/.25 carbon – .40/.60 manganese, on lower carbon, higher manganese grades such as .10/.15 carbon – .60/.90 manganese, and high sulphur grades.

Abnormal steel making practice can also lead to thin ingot skin on rimmed and killed grades. An effort is made to correlate this condition to proper heating practice since in many cases the heat can be saved.

Ingot cracking is related to slow delivery time and too rapid a thermal change in ingot skin when cold ingots are charged into hot pits.

It is pointed out that thin skinned ingots, high carbon and alloy steel ingots are very susceptible to cooling cracks. Slow delivery time will not only yield fine cracks on the ingots during cooling but it is emphasized that this condition is greatly augmented when these ingots are charged into hot pits. Severe bloom cracking results upon rolling and the conditioning costs are very high. With proper control of these conditions, it is brought out that bloom cracking can be practically eliminated and normal conditioning costs should result.

Attention is called to the necessity of standardizing upon definite time-temperature cycles for various grades of steel since bloom cracks will result if the ingots are not heated uniformly and to high enough temperature. Reference is made to the importance of proper pit design and operation in keeping bloom cracks and ultimate conditioning to a minimum.

Optimum rolling temperatures were found to play an important part upon the number and degree of bloom cracks. This condition was particularly observed on killed grades when being rolled on a three high mill.

An effort is made to point out that steel conditioning does not resolve itself into simply having the surface defects chipped out but requires a very thorough knowledge of the type of steel, the further processing of the material and above all how much money can be spent per ton to keep the price structure in line.

In conclusion, it is brought out that no one factor discussed will guarantee good surface results but that it is only by careful control in both the open-hearth and blooming mill departments that normal conditioning can be expected.

MAINTENANCE SHOPS IN THE STEEL PLANT

By T. R. Moxley

▲ A plant maintenance department is no more efficient than the provision made for shop equipment and personnel, as herein lies the controlling factor in the final analysis of the cost sheet. Shop equipment of today in the maintenance shop must be comparable with that of the machinery builder in quality, as modern steel mill machinery has improved in design to such extent as to require accuracy in maintenance not required in the steel plant a few years ago.

Assuming the above as a matter of fact it is necessary to establish a basis for the consideration of plant maintenance such as investment, necessary equipment, geographical location, and arrangement of equipment.

From a standpoint of investment, this would be a matter of company policy. Considering the matter of purchasing materials from outside manufacturers as compared to the manufacture of materials in the plant shops, not all steel plants are located in close proximity to manufacturing shops. Therefore, it is imperative that a large portion of maintenance items be manufactured in the plant shop. Also, when purchasing materials from outside concerns spare equipment requirements must be anticipated very closely.

In regard to the necessary shops, machine tools, and other equipment this will be presented for each shop individually. The geographical location of the plant shops department should be, as near as possible, centrally located in order to serve the greatest number of production departments readily accessible through transportation facilities such as railroads, truck roads, etc.

The arrangement of shop buildings and equipment is a matter of plant engineering and should provide the necessary facilities for handling materials through the department with the least possible interference.

Materials from the foundry and forge shop, properly identified by the order and drawing number, should be delivered to what may be termed casting and forging yard, which should be adjacent to the machine shop.

The shop department should consist of pattern shop, foundry, forge shop, boiler and structural shop, welding shop, carpenter shop, pipe shop, rigging shop, locomotive repair shop and machine shop. This within itself constitutes a department that when properly operated should be managed by a superintendent of shops, through whom all maintenance material is requisitioned.

The operation of a steel plant shops department involves many principals of management: efficient accounting system; production time study; personnel and apprentice training; application of proper materials; material expediting; simplified, yet effective and progressive, order system; job schedule system; budget system for control of man-hours; classification of rates and personnel; and finally, the production of maintenance materials in quality and quantity that will insure uninterrupted operation of the plant as a whole that will reflect its justification in the final analysis of cost per ton.

FACTORS AFFECTING PRODUCTION OF BLAST FURNACE GAS

By J. S. Fulton

▲ THE iron blast furnace in this paper will be analyzed on the basis of the character of its top gas. If it were to act solely as a gas producer, to produce gas for commercial combustion elsewhere, then little or no CO_2 would be generated. Since Fe_2O_3 must be reduced, in order to make pig iron the amount of O_2 transferred from the ore to the CO determines the amount of CO_2 formed and so alters the quality of the gas.

Some blast furnace operators feel that it is a reflection on the blast furnace to consider it as a gas producer "because the furnace is run to make pig iron." In so doing, they do not differentiate between the primary purpose and the primary function of the furnace. The primary function of the furnace, once the fire has been lit in the hearth, is the production of gas, and unless the gas has the proper percentage of CO, no iron can be reduced and so it defeats the primary purpose of the operation. The weight of top gas is several times that of the pig iron because it includes all of the weight of the blast, oxygen in the ore, CO_2 calcined from the limestone, nearly all the carbon and all of the moisture entering the furnace. The weight of the blast is at least double that of the iron produced.

Since the top gas reports the final combination between carbon and oxygen, it has balanced the carbon in the coke against the oxygen received in any manner, *i.e.*, O_2 in blast, O_2 in ore, O_2 in CO_2 from limestone, O_2 from H_2O dissociated anywhere in the furnace. By a coincidence the C in CO_2 calcined from the limestone about equals the weight of C needed for the pig iron and flue dust.

This relation may be set up as mathematical equations, and neither side of these equations may be changed without making a compensation on the other side. If the O_2 in the blast or in the solids is increased, it is necessary for a relative amount of carbon to shift from CO into CO_2, if the carbon rate does not change. This increase in CO_2 decreases the CO/CO_2 ratio from that previously shown.

Little attention has been given to the influence of the amount of hydrogen shown in the top gas other than as a cause of a minor change in the percentages of N_2, CO and CO_2 and a more markek change in the Btu value for further combustion. The Brassert curves show about 3½ per cent by volume of H_2, which represents about 20 lb. of H_2 in the lower carbon rates and was accompanied by 160 lb. of O_2 that had to be balanced in the equation A. This H_2 comes both from the blast and also in at least equal amounts from the dissociation of water accompanying the solids into the furnace. If the furnace continues to use the same carbon rate with an advance of H_2 it automatically increases the CO_2 and so decreases the CO/CO_2 ratio. It must be remembered that the furnace seems to make gas in accordance with its own need so it is usual to find that with two furnaces, with the same carbon rate the one following the practice of wetting the solids shows the lower CO/CO_2 ratio.

The writer suggests the desirability of the blast furnace profession getting together and preparing new curves of top gas production. In order to provide a better basis of comparison at least three sets are necessary, distinguished by the pounds of hydrogen per long ton, as 20, 30 and 40 lb. Each one of these will show a different CO/CO_2 ratio for the same pounds of carbon per ton. Since some of the corporations are basing their production on 2000 lb. tons it will be necessary to develop another set of curves for this ton.

Before these curves are developed it will be advisable to recognize that the present basis, "cubic feet of standard air 60 degrees F., 29.92 in. Hg.," gives no consideration to moisture in the atmospheric air and the amount of oxygen in this moisture.

Any change in the weight of C and O_2 supplied per ton to the furnace from any source must make a change in the top gas analyses, even though momentarily the

furnace may ignore the rate of supply and over eat or diet as it sees fit.

DESIGN AND OPERATION OF GEAR DRIVES

By F. P. Dahlstrom

▲ THE subject of gears, or perhaps more specifically, gear teeth, is one which is a fascinating study. The working surfaces of gear teeth are often highly stressed, and when we consider these stresses, together with the sliding which occurs between the loaded tooth surfaces, one is not inclined to ask why gear drives sometimes give trouble, but rather to inquire why they operate as well as they do. The modern gear drive is a very efficient and quiet mechanism, and has permitted the development of high speed sources of power which, in turn, has resulted in overall savings in weight and cost.

A gear tooth is a form of cam, for which many profiles have been proposed. The involute curve, however, is still considered to be the best by most designers. The involute profile combines uniform pressure angle with uniform motion; it can be generated directly from a straight sided rack; or from cutting tools which are generated from a rack profile; the teeth can be generated at one pressure angle and operated at another. The center distance between mating gears can be varied without losing the inherent constant pressure angle, constant velocity relation of the involute profile.

The paper shows various geometrical proportions of gear teeth which are easily obtained with involute generating gear cutting equipment.

To overcome the inherent non-uniform motion of spur gears with resulting noise, the helical and especially the double helical type of gears have been increasingly used in gear drives. The double helical type of gear, by moving axially, can also reduce load concentration caused by torsional deflection.

While the well-known Lewis formula still is useful in checking gear teeth for strength, the compressive stress (surface stress) formula is used to check the resistance of gear teeth to wear by pitting.

The maximum sliding velocities between gear teeth having standard tooth proportions varies from, say, 25 per cent, of pitch line velocity with drives having 40/40 teeth, to 46 per cent with drives having 20/20 teeth. The average is one-half the maximum.

With a drive having 30/150 teeth, the average sliding is 10 per cent of pitch line velocity. The coefficient of friction is about 3 per cent, which means that the losses in the gear mesh would be only three-tenths of 1 per cent, which is not far from the facts as determined by test.

It is a law of gear tooth action, that the sliding is distributed over the entire involute profile outside of the pitch circle, but over a lesser amount, say, one-half, of the involute profile inside the base circle.

In the absence of correct lubrication, more wear should occur below the pitch line, which is exactly what takes place. It is, therefore, most important that gear teeth should be continuously lubricated with clean lubricant in order that the original involute profile will be preserved.

Since high local temperature is undoubtedly associated with oil film failure, a study of the relative viscosities at 210 and 300 degrees F. was made, which shows that the viscosity of oils between these two temperature limits will vary from the square root to the fifth root of the viscosity at 100 degrees F. If we double the viscosity of the oil on the 100 degree basis, we increase its viscosity only 25 per cent in the higher temperature range.

Based upon these observations, it is easier to understand why extreme pressure lubricants were found necessary for hypoid gears where the relative sliding is high.

In the complete paper the writer has tried to more fully cover some of the general points of gear design and operation in such a way that the operating man will have a better conception of what a pair of gears is actually being asked to do, and hence be in a better position to select gears properly and especially to operate them successfully.

HOT SCARFING OF BILLETS, BLOOMS AND SLABS

By E. A. Doyle

▲ PREVIOUSLY developed methods of conditioning steel, such as chipping or hand-deseaming, did not, as a rule, permit a sequence of rolling and conditioning in one uninterrupted operating cycle. The success of the first de-surfacing machine demonstration definitely established the practicability of mechanically removing steel surface defects by the oxyacetylene process with equipment inserted in the mill roll table.

Conditioning is accomplished by this method while the piece is at rolling temperature. The process can be applied to all grades of steel generally rolled, except certain austenitic, stainless or corrosion-resistant steels. Machines now in operation are successfully conditioning materials ranging from ingot iron through the low-, medium- and high-carbon steels, as well as high-silicon electric steels, steels containing high percentages of manganese, and steels containing low percentages of nickel, chromium, vanadium, lead and copper. Materials are conditioned in the form of ingots, blooms, billets, bars, slabs, and rounds. All defects extending to a maximum depth of $\frac{1}{8}$ in. from the surface can be readily removed in one operation.

To meet the wide variety of mill conditions encountered, eleven production types of machines have been developed to date, operating procedures for which are fundamentally the same. Most machines are so operated as to produce an essentially flat surface, smoother than the original rolled surface, and devoid of ridges, fins, slag, cuts, or molten wash metal.

The six principal factors that affect the efficiency of the process are: (1) the composition of the steel, (2) the temperature of the steel, (3) the amount of scale, (4) the height of the nozzle from the surface of the steel, (5) the desurfacing speed, and (6) the rate of oxygen flow. In any desurfacing operation, the objective is naturally to strike the best combination of these factors so as to obtain the lowest possible "oxy-metal" factor which is defined as the cubic feet of oxygen required to remove one pound of steel.

Certain facilities for the installation of a hot scarfing machine must be provided by the mill. These include

provision of proper foundations and space in the mill roll table for the machine, as well as provision of the necessary piping, electrical conduit and wire, and other auxiliary equipment including facilities for removing smoke and molten slag. Power consumption does not normally exceed 4 kw. It is generally recommended that each machine be manned by two operators. Special equipment for the supply of oxygen at exceptionally high demand rates is essential and an integral part of the process. For the acetylene supply, special generating equipment has been designed, and is available.

The advantages of mechanized hot scarfing are many and varied. There is a tremendous saving in time since, taking as example the conditioning of a 10-in. square bloom, the overall speed ratio for equivalent work between mechanical scarfing and hand-deseaming is 144 to 1. There are also substantial savings in labor, crane charges, inspection costs, pickling, grinding and reheating costs. There is the value of improvement in the finished product. Furthermore, since scarfing of all four sides of a bloom or billet can be done simultaneously and since predetermined depth of cut can be rigorously maintained, it becomes possible to hot-condition grades and types of products which formerly were conditioned only by more expensive methods such as grinding or hand-chipping.

Repeated studies have indicated a 40 per cent direct saving in oxygen with mechanical scarfing over hand-deseaming, and further savings in preheat gases result from conditioning the metal when it is hot. Perhaps the most important advantage of all is the saving in time or cost realized where the product of an entire ingot can be conditioned in one or two passes through a hot scarfing machine, as compared with the required time and added cost of cutting the billet, bloom, bar or slab into shorter lengths and conditioning by any other method where constant handling and continual stopping and starting are necessary. This means that the conditioning of the rolled steel is accomplished with no reduction in the regular mill rolling time cycle, as has been proven in all installations to date.

APPLICATION OF DEMAGNETIZING AND IR DROP COMPENSATION TO COLD STRIP MILLS

By G. E. Stoltz

▲ WHILE the steel industry has produced strip either in single stands or in tandem mills for a period almost as long as we have had a steel industry, more advance in the art of producting strip has been made in the last six years than during the entire previous period. Previous to this time it was seldom that strip was rolled at a speed in excess of 300 ft. per min., but since that time there has been a continual increase in speed at which strip is rolled until today tinplate is being produced in a tandem mill in excess of 2000 ft. per min.

These mills are not only operating at higher speeds, but considerable improvement has been made in the finish of the sheet and the uniformity of gauge. With this rapid change in practice it has become necessary for the electrical manufacturers to provide driving equipment which will make it possible to operate these mills satisfactorily at higher speeds and obtain uniform gauge without causing too many breaks.

The finished gauge of the strip is the result of the combined roll pressure on individual stands and tension between stands. Roll pressure depends upon the setting of the screws while tension between stands is fixed by the speed adjustment of the driving motors.

As higher speeds are used it becomes more important to provide motors that have good speed regulation so as to maintain uniform gauge and avoid tearing the steel in two.

Recently electrical equipment has been furnished to drive a tandem tinplate mill which has been provided with auxiliary apparatus that compensates for the demagnetizing effect of the armature on the main field and the IR drop in the armature circuit.

This mill was started in April, 1940, and the compensating equipment which has been provided with the motors has demonstrated from the start of this mill that it constitutes a distinct improvement in the design of electrical equipment for a mill of this type.

LUBRICATION AND ITS RELATION TO MAINTENANCE

By C. W. Phillips and R. A. Barta

▲ A LUBRICATION engineer, or any planned lubrication program, is a definite maintenance aid in any plant. A definite understanding on how lubrication problems, or sources of trouble pertaining to lubrication, are to be handled can be made to show improvements when careful planning and follow-up is involved.

Various preliminary steps are involved in the selection of a machine or mill which is being purchased to perform a certain amount of work. The future maintenance on any machine involves an intelligent selection of all steps concerned. The method of lubrication is an important step, bearing on the future maintenance costs.

An initial survey of lubrication on a machine should include:

1. Checking points drilled for lubrication to see if lubricant will actually reach bearing surfaces.
2. Oil tight cases and lubricant retainers.
3. Accessibility of points to be hand greased.
4. Advisability of installing greasing or circulating oil systems.
5. Checking design of these features for most economical use of lubricants.
6. Clearance and replacement of bearings.

Selection of lubricants usually leads to a comparison of manufacturer's specifications with standard lubricants already being used elsewhere in the plant. Too many lubricants usually leads to confusion and unnecessary handling.

In any old or new mill a definite method for determining the schedule of lubrication, indicating all points of lubrication and the personal responsibility for these, should be charted in a clear detailed manner. Definite results have been obtained, where this procedure was used and carefully followed through. When charted lubrication is used, men are more interested in the lubrication of the mill and take greater care than they did previously.

A proposed schedule of lubrication may reveal weaknesses which may be used as a basis for recommendations to improve and obtain more efficient lubrication. These may involve:

1. New grease systems
2. Improved hand greasing equipment
3. Mishandling of equipment
4. Defects in circulating oil systems

The portion of maintenance cost due to lubricants, bearings, and labor for lubrication is only a small amount of the total cost. A monthly record of lubricants and bearing cost in each department can give accurate indication as to where help is needed in the maintenance program.

Crankcase oil for diesel locomotives can be maintained in a clean condition suitable for long periods of service. Efficient filtration of these oils has resulted in noted improvements in locomotive performance and maintenance. A viscosity curve can easily be developed for determining amounts of fuel oil dilution in crankcase oils.

Lubricants are one of the most expensive supplies used in the maintenance of machinery. Carefully supervised application of lubricants is the most important item in keeping these costs down. Automatic grease and circulating oil systems help out in this respect. Methods of reclaiming contaminated oils keep down oil consumption. Mixing of oils with extreme pressure bases results in highly effective and low cost extreme pressure oils.

The paper has attempted to indicate the importance of lubrication in its relation to maintenance and cites examples in which improvement in lubrication practice has resulted in improved practice and shown tangible returns.

OPEN HEARTH FURNACE CONTROL

By M. J. Bradley

▲ THE methods of controlling an open hearth furnace have changed considerably during the last five years. A few years ago, so many varying conditions seemed to be connected "inherently" with ordinary open hearth furnace operation that it was considered almost impossible to control them except through manual operations by the first helper. However, the demand for quality steel to meet rigid specifications has emphasized the importance of maintaining operating conditions within narrow limits in order to be able to meet the specifications. This has convinced the first helper that he requires tools—instruments, if you please—to measure accurately the various conditions which he wishes to control in order to maintain the narrower operating limits. The better control resulting has eliminated a great many of the so-called "inherent variables," which were so confusing. Consequently, the control of an open hearth furnace is now being reduced to the control of fundamentals. If these fundamentals are capable of being controlled by manual operations, guided by the information obtained by measuring instruments, the same set of conditions can be maintained by combined measuring and controlling instruments which are coordinated to control the same fundamentals.

The necessity for the control of temperature conditions within the open hearth furnace and system, in the last analysis, is a fundamental requirement in the operation of the open hearth furnace. The reason for controlling certain factors which contribute to the temperature conditions may be outlined under the particular operation to which it is more closely related. However, in open hearth control conditions are so interrelated that it is difficult sometimes to be able to make a distinction between cause and effect.

The combustion air used in an open hearth furnace must be preheated in order to obtain a flame temperature high enough to melt scrap and to make steel. In order to maintain the temperature of the preheated air within narrow limits the direction of travel of the waste gases and combustion air must be reversed at frequent intervals. The reversing operation should be carried through in a definite sequence and in the shortest time possible in order to decrease the loss in temperature through radiation while the fuel is off. On the majority of the open hearth furnaces the reversing operation can be carried through more efficiently by mechanical means.

The pressure conditions within the open hearth furnace play an important part in the furnace operation, especially in the direction and location of the flame, the fuel economy, the temperature, the heat distribution, the production, and the refractory repair and life.

In order to control combustion conditions it becomes necessary to measure and control the volume of the combustion air as well as its temperature, and also the volume and temperature of the fuel. Theoretical proportions of fuel and air for maximum combustion efficiency are not always best suited to meet all operating conditions. Provision should be made to vary the fuel-air ratio sufficiently to produce a sharp or a heavy flame condition for special heats or unusual operating conditions.

Roof temperature control has improved and changed in two important respects. First, the method of measuring the temperature of the roof. This is done by sighting through a suitable hole in the back wall upon the underside of the roof. Second, the method of using this temperature to control the fuel input. Instead of being used as a limit control, the roof temperature is now being used to regulate the fuel input to maintain the roof temperature at its safe maximum limit throughout all stages in the heat.

MERCURY ARC RECTIFIERS FOR MAIN ROLL DRIVES

By L. A. Umansky

▲ THE American steel industry is not yet using mercury arc rectifiers to any large extent. One 1000 kw. unit was installed in 1937 to supply 250 volt constant potential power in a wire drawing plant; another 1000 kw., 250 volt unit was put in service elsewhere a few months ago; and a third unit, of 1500 kw. rating, also

for constant potential power supply, has been just ordered. In addition to this, two 3500 kw., 600 volt units are being built for a hot strip mill. On the other hand, the European steel mills have been using rectifiers, both for d-c. auxiliary power and for main roll drives for 15 years or more, and their use is spreading.

From an application viewpoint the rectifier is nothing but another form of a-c. to d-c. converting equipment. If we are to use it, we must gain on some of the following points more than we might lose on others, or we must gain on all of them: first cost, higher efficiency, lower installation cost, lower maintenance cost, reliability, or effect on power system.

The paper discusses the application of rectifiers to constant potential main roll drives, to non-reversing drives requiring Ward-Leonard control, and to start-stop, reversing drives.

In case of main roll drives, the application of rectifiers would be hardly considered at all, if it were not for their better efficiency, or, to put it differently, for their lower operating losses. The floor space requirements and installation costs are not necessarily or always reduced with the rectifiers. In many instances the rectifiers and their associated transformers must be located quite close to the main drives. There may be no "outdoor wall" in the motor room, beyond which to set the transformer. The problem of suitably locating it, without introducing a fire hazard, must be solved.

A main drive motor room, whether provided with motor-generator sets or rectifiers, contains in either case some rotating equipment. If the latter requires an attendant, then the use of rectifiers can not give us an "unattended substation."

The operating characteristics of rectifiers for certain types of main drives can be made fully comparable with those of motor-generator sets, and practically as good as the latter. However, they are not any better.

Summing up, the rectifier is a new, somewhat more efficient tool for converting a-c. supply into d-c. power. For many applications it fits quite well and has definite merits. Hence, it is reasonable to expect its gradual spread in certain fields of main roll drives. This field has no definite limitations. Experience and developments may gradually widen these limits. We should follow this path of development with optimism, but without haste.

SOAKING PIT CONTROL

By M. J. Boho

▲ ENGINEERING development progresses in cycles. In the case of the automobile industry, for example, engineering emphasis a number of years ago was placed on four-wheel brakes, similarly, on silent transmissions, floating power, streamlining, etc. Upon completion of each of these engineering developments, the ideas were accepted by the entire industry and the engineers moved on to other problems. In much the same way, the steel industry found its engineers a number of years ago occupied with the continuous rolling process. This development emphasized the importance of proper ingot heating in the soaking pit and soon steel mill engineers found themselves giving considerable study to pit operation and design. As a result of this study, several important conclusions are apparent. As compared with pit practice prior to say five years ago, present-day pit designs produce more and better heated ingots at lower cost.

Over one hundred and fifty new soaking pits of latest design have been paying their owners remarkable dividends. These newer units have been built in several different shapes—round, square, and rectangular. While different in construction and method of operation, all of these pits have one thing in common—they all include automatic control as an integral part of the installation.

The functions of the automatic control apparatus follow in principle the operating methods used by the heater when operating the pit under manual control, with the exception that the temperature, atmosphere, and pit pressure, instead of being judged by the variable yardstick of the heater's guess, are now based on direct measurement of the quantities involved. Operating conditions, therefore, are more easily determinable and can easily be reproduced.

The divisions of control on a soaking pit may be divided as follows: (a) rate of heat input, (b) fuel-air ratio or furnace atmosphere, (c) flue gas removal or furnace pressure.

In connection with control of heat input, the rate of fuel flow to the pit should be in proportion to the ability of the steel charged to absorb the heat. Due to difficulties in measuring the actual heat absorbing ability of the steel and due to the fact that a time interval is involved in the transmission of heat from the exterior to the interior of the ingot, heat input control to date has been on the basis of the temperature existing in the pit at a point or points representing the combined pit and ingot temperature. On the whole, this has worked out successfully, but occasions may arise when the temperature of the control point bears a variable relation to the temperature of some of the ingots within the pit. This, in some cases, has caused irregular results, and bears further study.

In connection with fuel-air ratio control, it must be borne in mind that before a quantity can be precisely controlled it must first be accurately measured. The optimum proportion of fuel to air to be maintained is not necessarily a constant, but in many cases has been found to call for a higher percentage of excess air as the rate of firing decreases.

The pressure within the soaking pit chamber is an indication of the balance between gas and air input and flue gas removal. In the past, furnace pressure controls were installed because their use effected a decided saving in fuel by elimination of air infiltration. Modern soaking pit construction includes effective insulation, steel enclosed construction, and covers equipped with sand seals. The air infiltration problem, therefore, is considerably reduced. The need for furnace pressure control, however, remains since the draft at the pit outlet determines the path of the gases of combustion through the pit and also the effectiveness with which ingots in all parts of the pit are heated.

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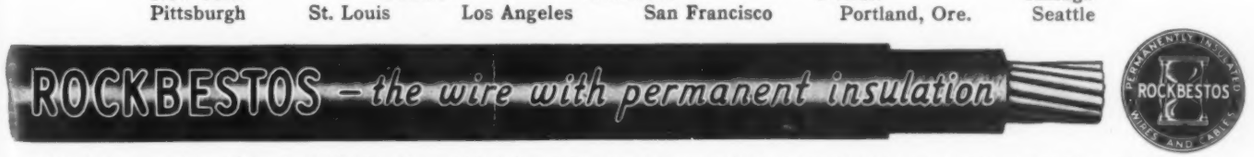

A typical construction — Table R, 600 Volt Rockbestos All-Asbestos Power and Rheostat Cable — One of 118 different heat resisting wires and cables.

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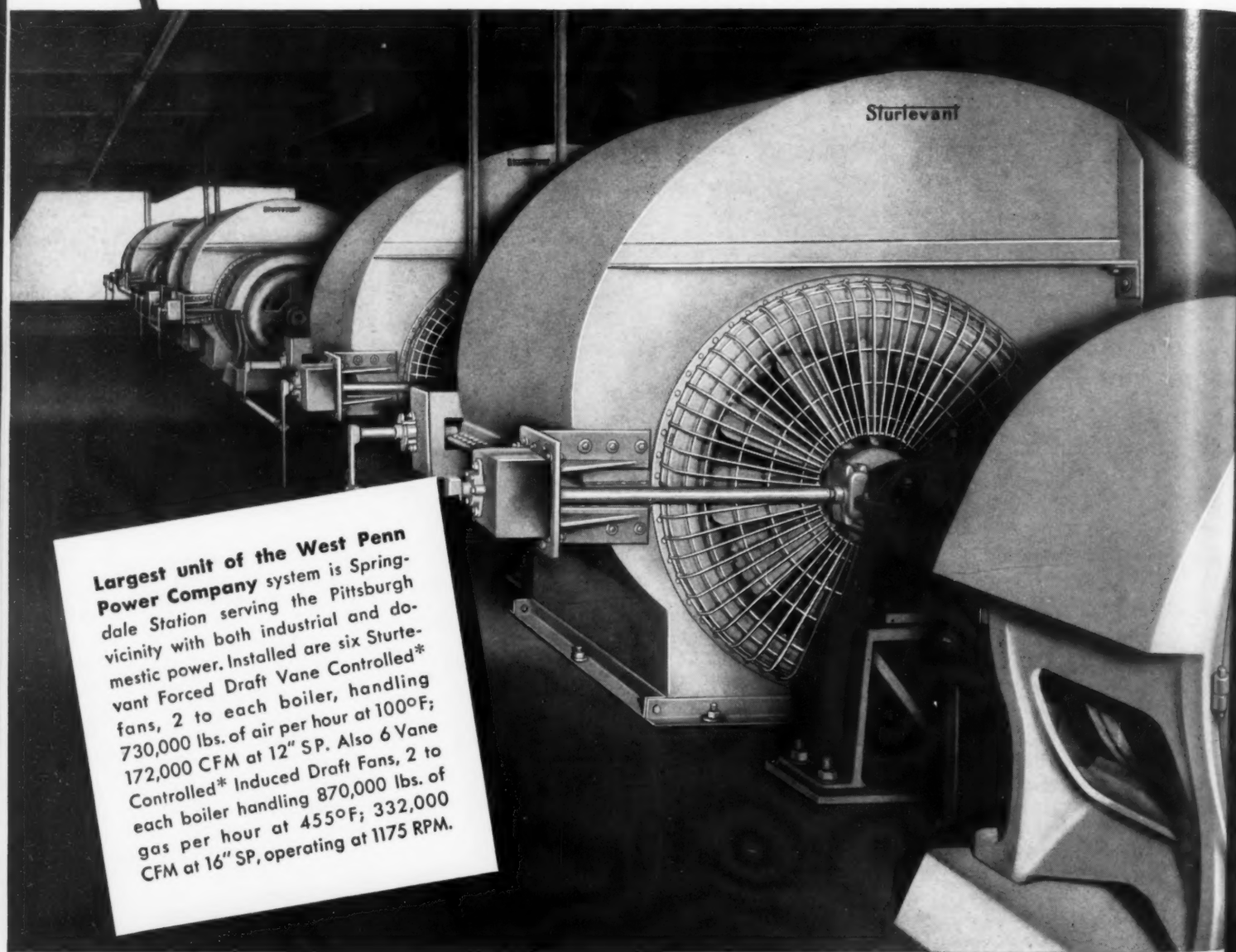
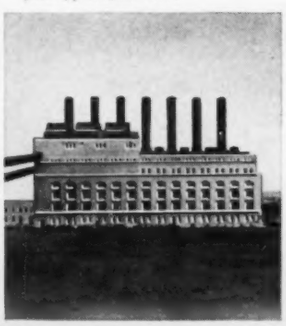


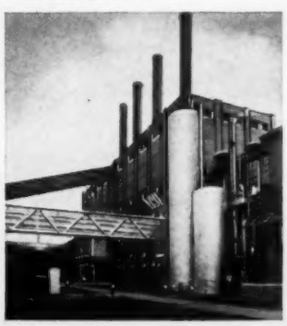
Largest unit of the West Penn Power Company system is Springdale Station serving the Pittsburgh vicinity with both industrial and domestic power. Installed are six Sturtevant Forced Draft Vane Controlled* fans, 2 to each boiler, handling 730,000 lbs. of air per hour at 100°F; 172,000 CFM at 12" SP. Also 6 Vane Controlled* Induced Draft Fans, 2 to each boiler handling 870,000 lbs. of gas per hour at 455°F; 332,000 CFM at 16" SP, operating at 1175 RPM.

At Seward Station of the Pennsylvania Electric Company, 4 Sturtevant Vane Controlled Induced Draft fans serve Boilers 2 and 6 of the 60,000 KVA capacity station.

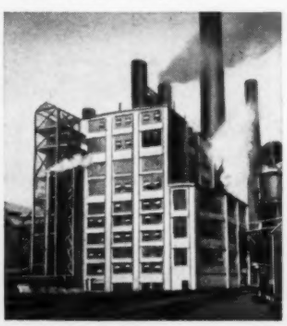
12 Sturtevant fans handle a total of more than 1,500,000 cubic feet of air and gas per minute, at *Springdale Station*, West Penn Power Company. Station capacity, 210,000 KW.



At East Pittsburgh Plant, *Westinghouse Electric and Mfg. Co.*, 8 Sturtevant Forced and Induced Draft Vane Controlled Fans handle a total of 549,300 CFM of gas or air.

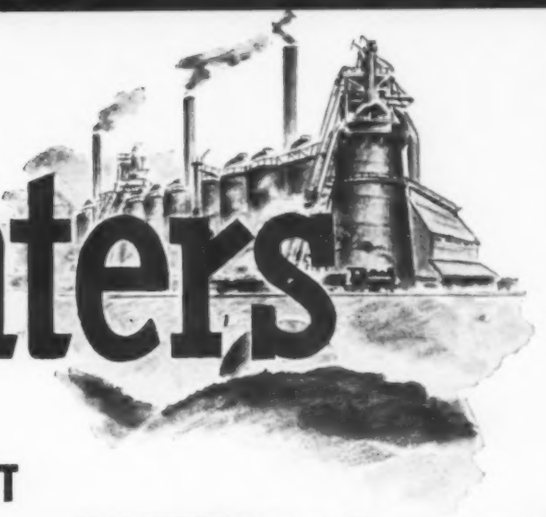


In the High Pressure Boiler House of large steel company, 3 boilers with peak output of 500,000 lbs. of steam per hour, 820° F, 825 lbs. pressure are served by 3 Sturtevant I.D. fans.



Warren, Ohio station of Ohio Public Service Co., where Sturtevant Forced Draft fan serves the 68,320 KVA capacity station, handling 69,200 CFM of air at 80° F and 10.5" WG pressure.

Steel Centers



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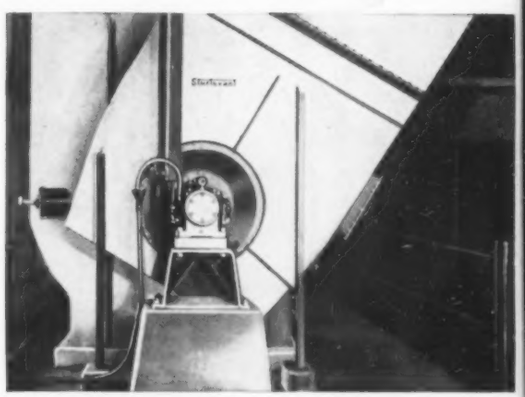
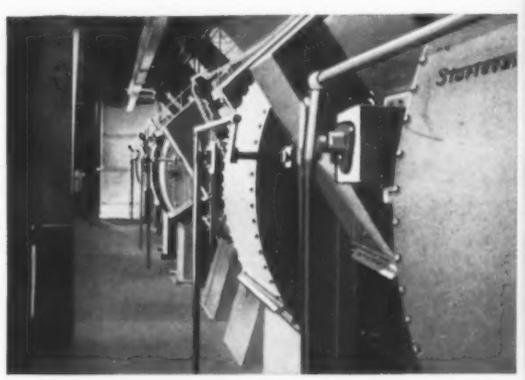
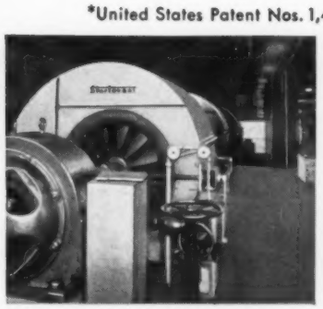


One of 4 Sturtevant Vane Controlled* Induced Draft fans serving two boilers at 60,000 KVA capacity, *Seward Station* of Pennsylvania Electric Company.

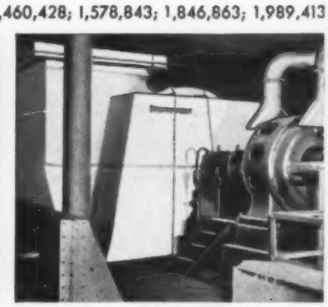


Six Sturtevant Induced Draft fans serving 3 Babcock & Wilcox boilers, each evaporating 500,000 lbs. per hour at 1450 lbs. pressure and 935° F at *Springdale Station*, West Penn Power Co.

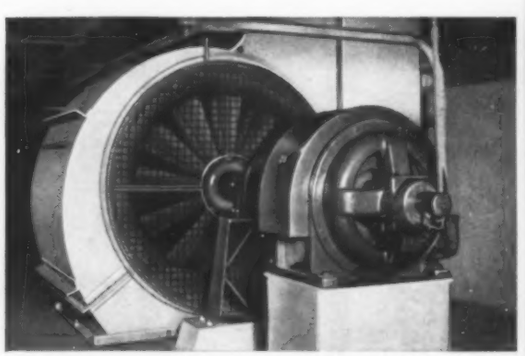
8 Sturtevant I.D. and F.D. Fans serve 2 boilers at Rivesville Station, Monongahela West Penn Public Service Co., Fairmont, W. Va. Each boiler rated—3[illegible]5,000 lbs. per hour, 1425 lbs. pressure 915° F.



At Windsor Plant, Beech Bottom Power Co., American Gas and Electric Co. group, Power, W. Va., 2 boilers, each 750,000 lbs. per hour, 1350 lbs. p., 925° F, are served by 4 Sturtevant Vane Controlled F.D. and 4 Sturtevant I.D. Fans.



Six boilers in Boiler House No. 5 at Campbell Works, Youngstown Sheet and Tube Co., are served by 12 Sturtevant F.D. and I.D. Fans. Fan shown handles 600,000 lbs. of gas per hour at 550° F, 12.4" SP.



Sturtevant Vane Controlled* Forced Draft fan, handling 69,200 CFM of air at 80 degrees F and 10.5" WG pressure, serves 68,320 KVA capacity Station of Ohio Public Service at Warren, Ohio.

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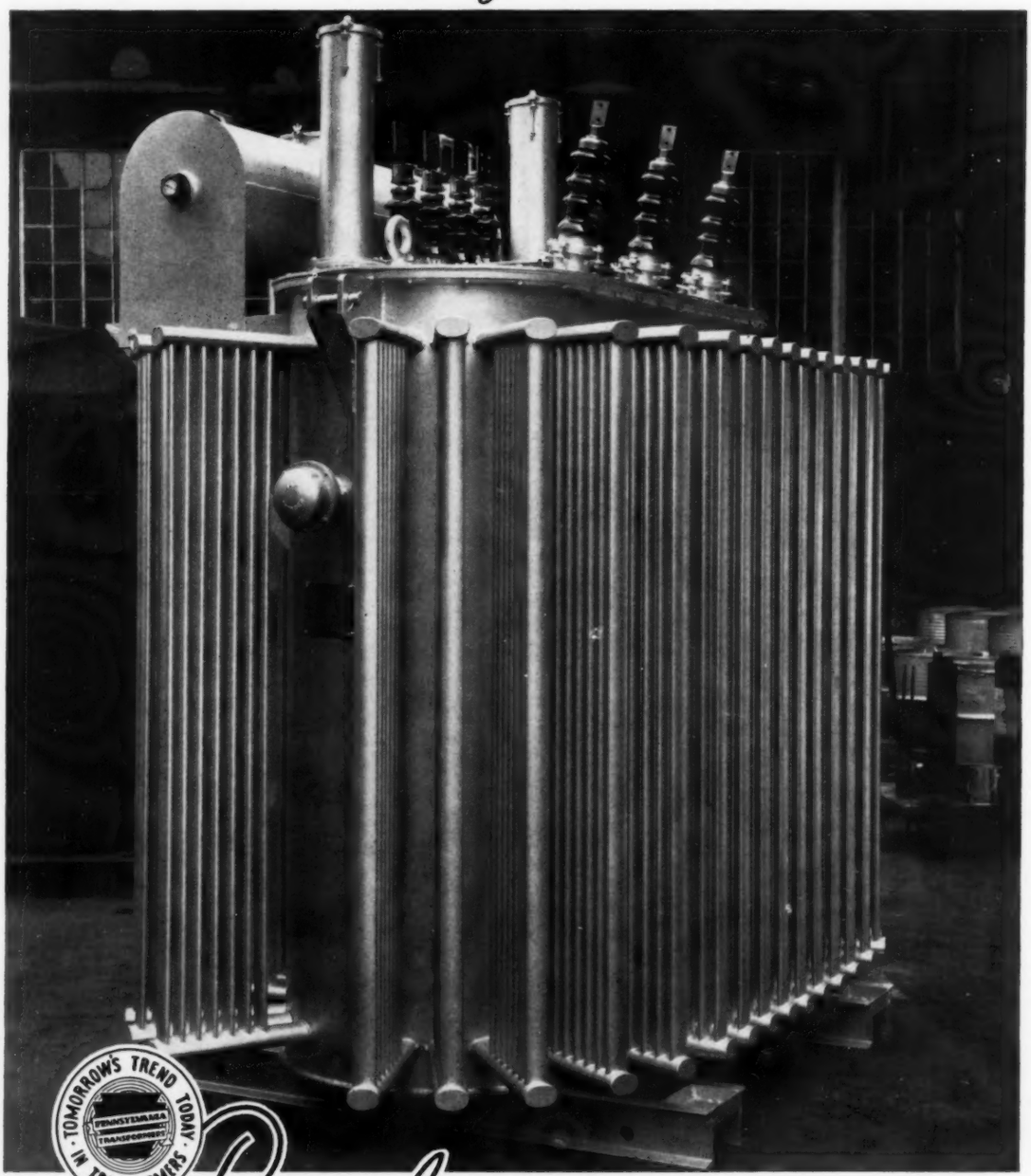

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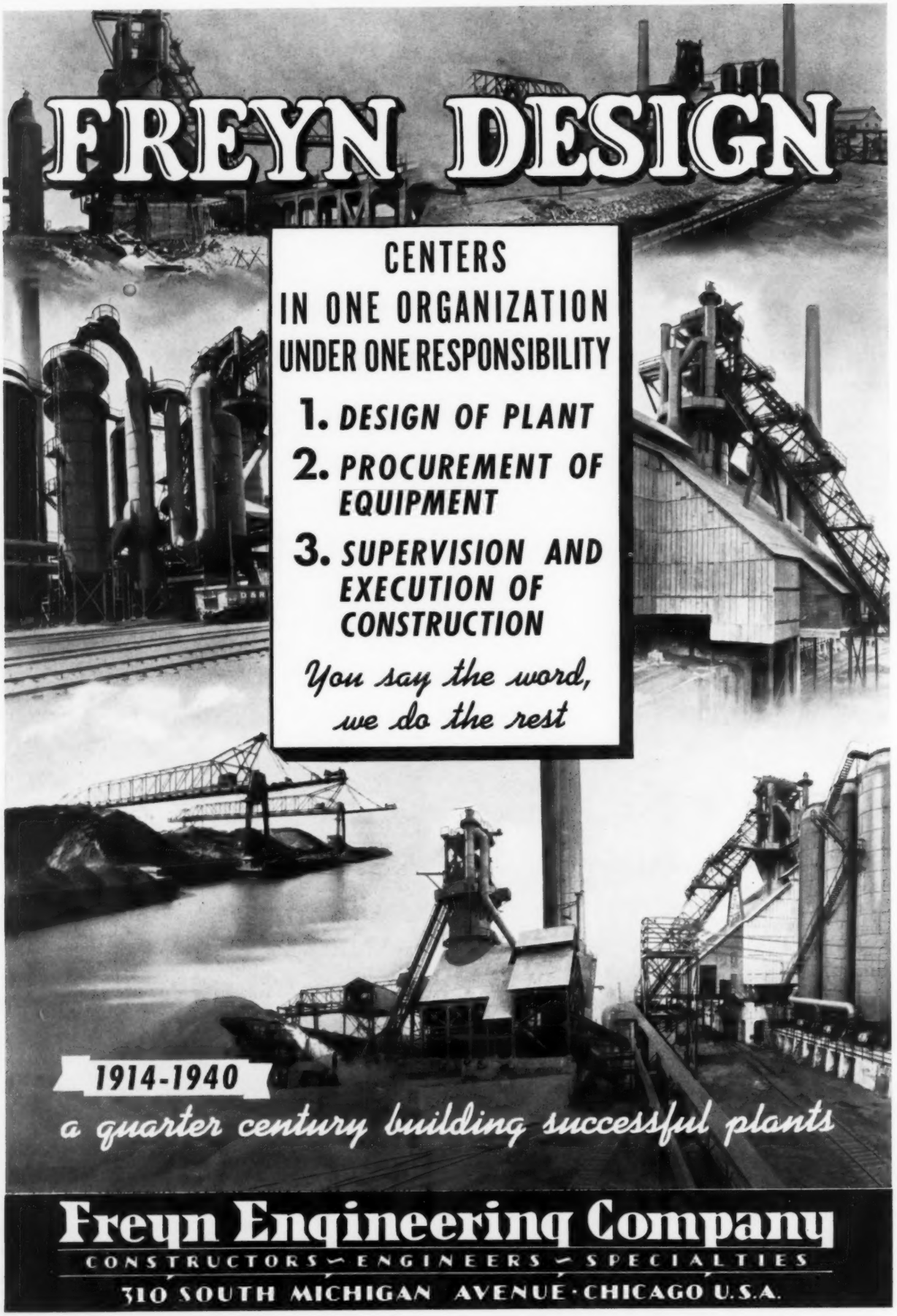
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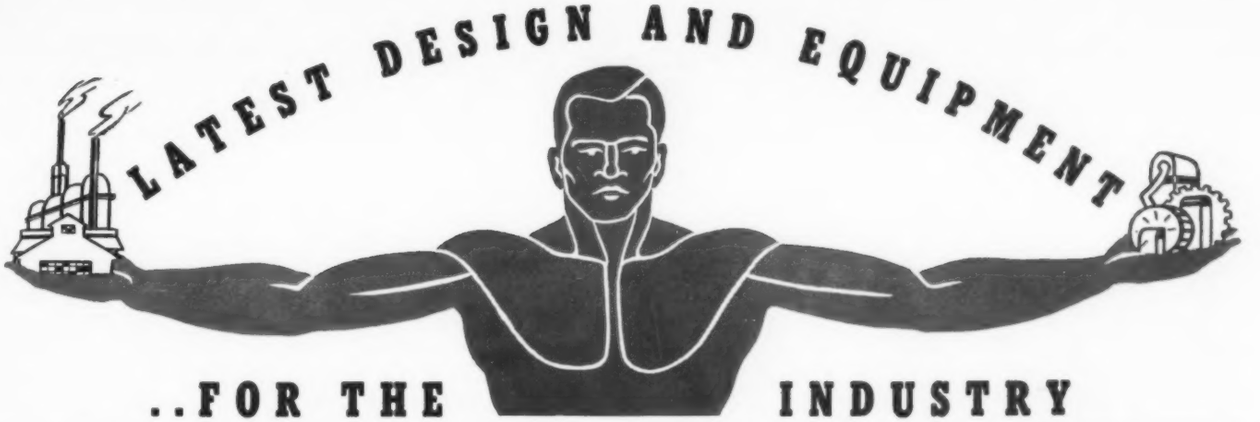


IMPROVED DOLOMITE MACHINE GENERATES OWN DRIVING POWER

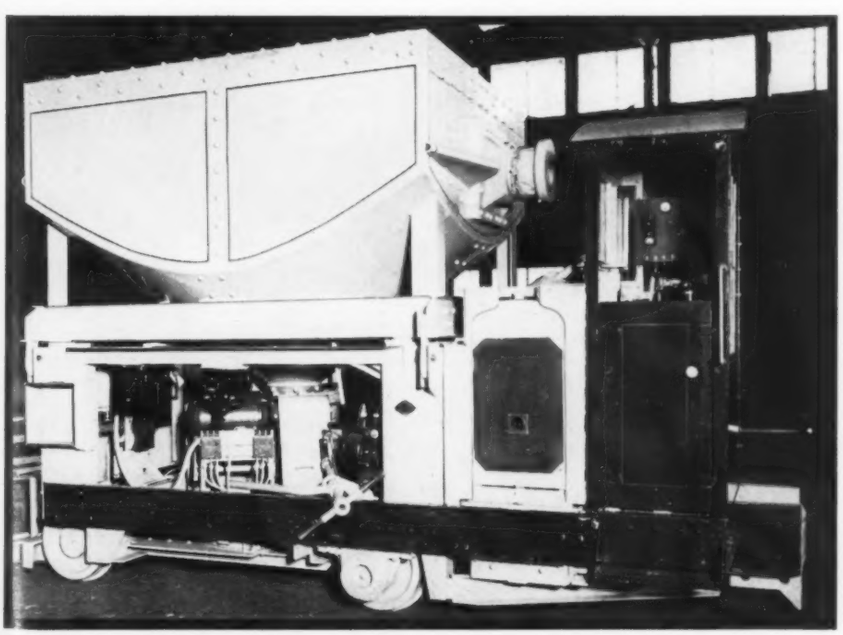
▲ An improved dolomite throwing machine for making up open hearth banks is offered by the Blaw-Knox Company. A principal advantage of the improved machine is that it operates under its own power. A generator, driven by either a diesel or gasoline engine, develops the electric power needed for the motor which drives the dolomite throwing mechanism, and also for the motor which propels the machine along the rails. This enables the machine to transport dolomite from storage as well as throwing it to the furnace banks, and makes crane service unnecessary.

In the machines of earlier design, electric power is obtained by plugging in a power cable. This limits the machine travel to relatively short distances along the charging buggy rails and makes crane service necessary for longer travel.

The hopper is removable from the machine proper and is fitted with trunnions for engagement with the hot metal ladle hooks of the floor crane, so that it can be used by itself to transport dolomite from storage to the open hearth floor. Hopper capacities are made to suit local conditions and are generally designed to hold sufficient material to make up banks for three heats.

Another improvement is provision, where desired, of a divided hopper, so that two classes of material—*e.g.*, raw and double burned dolomite—can be handled at the same time by the mere manipulation of separate levers.

This new dolomite machine is equipped with a diesel-electric generator set which enables the machine to develop the power needed for the motor which drives the dolomite throwing mechanism.



NEW ELECTRIC HEATERS FOR POT FURNACES

▲ A new type of heater (rated for use up to 950 degrees F.), for operating in molten salt, metal and high temperature oil baths has been announced by the Edwin L. Wiegand Company.

Heavy-duty "Chromalox" tubular units are welded to an electrical connection housing to which a riser is attached, connections being brought out to the terminal box in which line connections are made.

Operating conditions determine the use of steel or inconel sheath, 1/16 in. in thickness with wattage ratings from 2 kw. to 5 kw. at various watt densities.

DESIGN CRANE TONGS FOR MAXIMUM SAFETY

▲ Equipment that will improve efficiency and speed and also aid in eliminating employee accidents should prove of interest to every industrial executive or works manager. In plants where materials have to be handled by cranes or hoists, which includes practically every industry, the use of Gellert tongs, now produced exclusively by Heppenstall Company, decreases hazards to life and limb, and cuts lost time to a minimum.

All that is required with these tongs is to lower the tongs on to the work, and the tongs do their job automatically. The craneman has entire control, and ground men do not have

to throw chains around hot ingots or forgings, nor climb to the top of scrap piles with danger of slipping or being crushed by material rolling down.

Several types of these tongs are in successful operation in steel mills and

The working parts of these tongs are made of molybdenum steel to provide greater strength.

foundries for handling ingots, ingot molds, die blocks, pipe, and wire; and other special designs are made for non-ferrous metal ingots or shapes, paper bales, sacks of sugar and similar materials. Lifting capacities run as high as 200,000 lb.

DESIGN VOLT-AMMETER TO HOOK AROUND LINE

▲ The hook-on volt-ammeter, a versatile, portable instrument, for measuring alternating current and voltage has been developed by the General Electric Company. With it, alternating current can be read instantaneously on both insulated and non-insulated conductors simply by hooking the instrument around the line. For voltage readings, it is necessary only to connect two leads furnished with the instrument and then flip the thumb-manipulated selector switch to the desired voltage position on the scale.

Designed for use on conductors of 2 in. maximum diameter, the new volt-ammeter is small enough to get into tight places, light enough to be hung from a lineman's belt, and sufficiently accurate for a great variety of measuring jobs. Weighing only 3½ lb., it is designed for easy, one-hand operation. Four current ranges, 0-15/60/150/600 amperes, and two voltage ranges, 0-150/600 volts are available at the setting of a convenient six-position snap switch. Its accuracy is within 3 per cent.

An integral part of the instrument is a C-shaped, split-core current transformer so designed that it can be operated without a trigger. To make measurements, the transformer is simply pulled open and placed against the conductor.

A slight push on the handle snaps the transformer shut. The measurement completed, a gentle pull springs open the dovetail joint of the transformer and releases the conductor. The dovetail joint assures that particles of dirt, which would cause large errors in the ordinary butt joint, have almost negligible effects on the indication.

The transformer, indicating instrument, internal resistors for extending the range, and selector switch are all mounted in a single textolite case. The handle, molded as part of the case, provides insulation and maximum safety for the operator. A convenient slot for a carrying strap is molded in the handle.

DEVELOP TRANSFORMERS FOR MERCURY LAMP USE

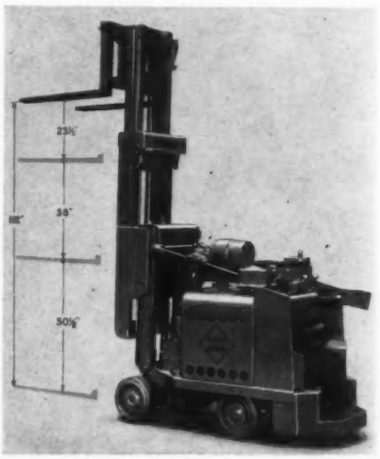
▲ To their line of transformers for use with mercury lamps, the Jefferson Electric Company has added two types, each of which is designed to operate two 400-watt mercury lamps. The indoor type is rectangular in shape for wall or post mounting with brackets for easy installation, and with terminals made accessible by means of small doors at top and bottom. The weatherproof pole mounting transformers, also illustrated, have terminals accessible at the bottom, and three threaded hubs so that up to three fixture mounting supports may be used. Each type serves two 400-watt mercury lamps reducing installation costs where numbers of lamps are used in the same room or location.

ELEVATING TRUCKS HAVE THREE-LEVEL OPERATION

▲ A new type of fork truck, capable of elevating loads on skids or pallets to three levels instead of one, has been brought out by the Elwell-Parker Electric Company. The elevating mechanism is built in three telescoping sections. When uprights are completely lowered, the forks just clear the floor. At the operator's will, forks can be raised to 50½ in. on the first lift, to 88½ in. on the second, and to 112 in. on the third. The rate of upward travel is 20 ft. per min. with a 1500 lb. load. With telescoping members lowered, the overall height of the truck is but 74 in. Thus the loaded truck can pass through doorways or beneath low overhanging pipes or conveyor systems.

The main driving motor is 4-pole, series wound, capable of sustaining a 500 per cent overload. It is direct-connected to a free-coasting worm and gear, and drives the two wheels nearest load, assuring ample traction. Power source can be either acid or alkaline storage batteries. No fuses are needed to protect motor. When lowering load, regenerated power is returned to the battery.

Hoist is operated by a separate motor controlled by push-button. It may be tilted 15 degrees backward or



In this new fork truck, drive wheels are 15 in. in diameter and 5 in. wide. Trail wheels are same diameter and 3½ in. wide.

5 degrees forward from vertical. The two hoist chains have a safety factor of 9 and either will handle the load. Vertical uprights and tilt gearing are designed to prevent sideway.

Hoist is provided with ratchet device, which operates when the descending load meets an obstruction.

ORDER NEW COKE OVENS FOR LACKAWANNA PLANT

▲ Bethlehem Steel Corporation has awarded a contract to the Wilputte Coke Oven Corporation, subsidiary of Semet-Solvay Company, for a battery of coke ovens for its Lackawanna, New York steel plant.

The battery of ovens will consist of 76 under-jet combination ovens having a coking capacity of 560,000 tons of coal per year, which is equivalent to approximately 32,000 tons of coke per month.

This is the first contract awarded since Semet-Solvay and Wilputte have joined forces in the coke oven construction field and it is expected that the design of the ovens and accessory equipment will represent definite improvements that will make the installation the most modern and efficient yet constructed in this country.

Engineering details are now being worked out and it is expected that the ovens will be in operation by next spring.

COMPLETE POWER UNITS FOR SPECIAL PLANT USE

▲ A new and completely self-contained a-c. generating unit which regulates, controls, and meters its output has just been announced by the Westinghouse Electric and Manufacturing Company. Called the "Simpac" power unit, it combines a standard open-type a-c. generator, a direct current exciter, exciter field rheostat, voltmeter, ammeter, and optional voltage regulator in one integral unit. The "Simpac" was designed especially to fill the need for a completely self-contained generating unit for use in out of the way localities, or for special requirements in industrial plants. It may be either engine or electric motor driven, direct or belt connected.

MASTER SWITCH GIVES THREE-WIRE CONTROL

▲ A new drum type master switch providing 3-wire control for machine tools and other equipment is announced by Cutler-Hammer, Inc., manufacturers of motor control and allied electrical equipment. This new type switch affords functions equivalent to two and three button heavy duty push button stations and is offered for use where an operating lever is preferred.

Three kinds of constructions are available—surface, cavity, and panel mounting—and two kinds of handles, standard and pistol grip By removing a stop post, the drum may be converted from non-reversing to reversing.

Ratings of the new drum type master switch are for pilot circuits up to 600 volts a-c. and d-c.

SIMPLIFY METHODS OF PROCESS DUST CONTROL

▲ The control of process dust is recognized today as an essential requirement in modern industry. The introduction of new high-speed operations and processes; the value of

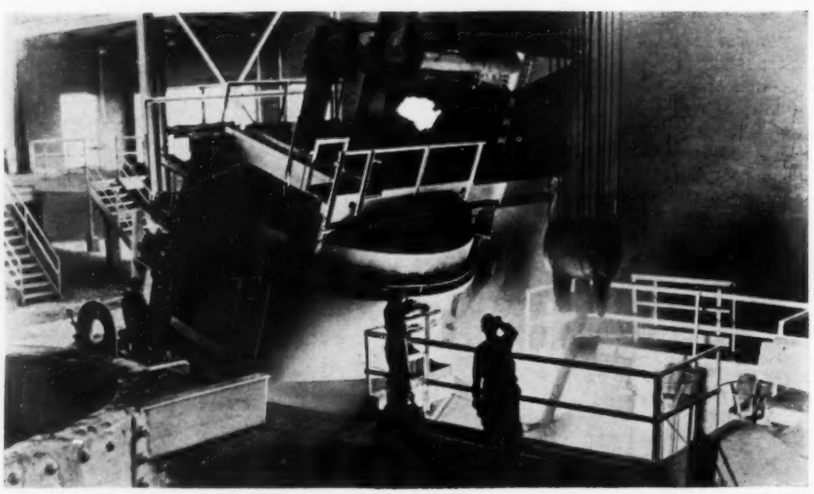
AMCO'S part in the preparedness program
Ordered in last three months—21 AMCO PIT FURNACES... total heating capacity 2,500,000 tons
Gun Forging Furnaces
AMCO-designed Pulverized Coal Systems
Gun Annealing Furnaces
Rotary Hearth Furnaces
Continuous Rail Re-Heating Furnaces
In these times of heavy demands on Industry, AMCO'S experienced engineers can help speed production and lower cost with specially-designed Furnace Equipment to meet your individual requirements.
Continuous Bloom Heating Furnaces
The AMSLER-MORTON COMPANY
FULTON BUILDING • PITTSBURGH, PA.

"good housekeeping" in maintaining production schedules; a better understanding of the hygienic effects of dust; the importance of keeping down maintenance expense and preventing premature deterioration of buildings and machinery—all these and other factors have made efficient dust control a necessity in almost every industrial plant.

Fundamentally, a dust control system consists of enclosures or hoods at the source of the dust, piping to convey the dust laden air, an exhauster to draw the dust from the source, and a separator to remove the dust from the carrier air. Most types of dust collectors or separators are so large that they are usually installed outdoors. This requires long pipe runs, increases the power consumption of the system and adds materially to the cost of installation.

The Roto-Clone, which has been developed by the American Air Filter Company, Inc., has greatly simplified the customary method of controlling process dust. Since it performs the functions of exhauster and separator in a single unit with maximum efficiency, only piping and hoods are required to complete a dust control system. The compact design permits it to be located near the source of the dust; allows dust producing operations to be placed at the most advantageous location in the production line, and has made it possible to work out new systems of dust control that have the advantages of greater simplicity, increased efficiency, extreme compactness and lower operating cost.

AN EXAMPLE



OF A
MODERN INSTALLATION
OF
HIGH CAPACITY

SWINDELL

ELECTRIC ARC MELTING
FURNACES

THE PHOTOGRAPH SHOWS ONE OF A PAIR OF 16;-0. SWINDELL SWINGING-PROOF ELECTRIC ARC MELTING FURNACES, EACH OF 35-TON CAPACITY, AT THE COPPERWELD STEEL CO., WARREN, OHIO.

SWINDELL SWINGING ROOF
FURNACES
PRODUCE HIGH-GRADE STEEL
AT LOWEST COST

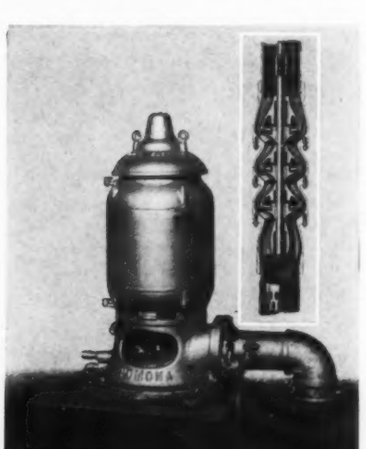
SWINDELL-DRESSLER CORPORATION
PITTSBURGH, PA.

IMPROVED TURBINE PUMP LOWERS OPERATING COST

▲ A complete redesigned line of 6 in. medium capacity vertical turbine pumps is announced by the Pomona Pump Company. As a result of improved engineering practice, particularly in the newly designed impellers and seats, the manufacturer states that the new models afford higher efficiency and better performance, resulting in lower cost for the user.

For a desired capacity of 100 gal. per min. against 110 ft. lift in a well and 50 lb. pressure above, a 7½ hp. motor is required, as against a 10 hp. motor with the old model. The efficiency of this particualr size pump for this head capacity has been increased 6½ points, the number of stages has

Improved engineering practice has aided this vertical turbine pump in giving efficient performance at lower operating cost.



been reduced one-fourth and finally, the initial cost of the entire unit has been lowered 20 per cent.

Other advantages of these pumps, making for extremely low operating costs, lie in the facts that they are water-lubricated, with no stuffing box below ground level; that the specially-designed semi-open impeller can be adjusted from the surface for wear and for changing capacity; and that they are non-sandlocking and non-gaslocking.

Constructed of high quality bronze, the semi-open impellers operate in a cone-shaped seat in the pump bowls. Correct curvature of the impeller vanes assures maximum lifting capacity and prevents overloading of motor regardless of changes in water level.

ANNOUNCE NEW BEARING OF MODIFIED DESIGN

▲ A modification in the design of the standard NA type, or non-adjustable, Timken roller bearing has been released by the Timken Roller Bearing Company. Made up of a double row outer race or cup and two single row inner races or cones, it is especially adapted to serve as a sheave bearing. The races and rolls are ground to established precision limits so that when the cones are assembled into the cup the front faces of the cones contact and the proper running clearance is provided. The front cone faces are slotted and chamfered as shown to provide an entrance for lubricant to within the bearings. This feature is particularly advantageous in multiple sheave blocks where it is required that the bearings be lubricated through the pin which is stationery.

The chamfered front faces eliminate the necessity of machining a deep annular groove around the shaft to carry the lubricant to the various points of entrance in the bearing. In some sheave blocks, lubricant may be introduced through a fitting in the sheave hub, and for this design an annular groove and holes are provided in the cup.

The problem of sealing the bearing chamber has been greatly simplified by extending the length of the large cone rib and creating a surface concentric with the shaft and sheave bore on which a seal may be run.

▲ Brown Instrument Company has available for distribution a new booklet featuring a new line of thermometers and pressure gauges. This booklet describes the vapor-actuated, gas-actuated, and mercury-actuated types of thermometers. Indicating and one, two and three pen recording models are illustrated.

Copies of Booklet No. 2-17 may be secured by writing direct to the Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania.

▲ Bailey Meter Company has issued a bulletin describing a new product which warns boiler operators of possible furnace explosion that may result from loss of ignition. This booklet points out that the best assurance against an explosion hazard resulting from the loss of ignition is for operators to be fully acquainted with furnace conditions and for them to know that ignition is satisfactory.

Write to the Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio, requesting Bulletin No. 210.

They "see" what's going on in the soaking pits—

HAYS COMBUSTION INSTRUMENTS AND CONTROL INDICATING AND RECORDING INSTRUMENTS ACCURATELY DEPICT GAS PRESSURE, FURNACE PRESSURE, AIR FLOW

In the above installation a Hays "OT" Recorder (pane at the left) accurately records the gas pressure for every minute of the day and night. An Air Flow indicator (upper panel) shows continuously the air volume and flashes a warning signal when it reaches 25— of the load or lower. At the same time a Hays "D" Gage indicates the pressure *inside* the furnace. Thus is guesswork and uncertainty eliminated.

Hays Combustion Instruments have set the standard for accuracy, dependability and stamina for 38 years. They are as well known in the steel mills and power plants of the country as a monkey wrench. They can be designed to meet practically any requirement concerning indicating, recording and controlling of combustion conditions. Hays Engineer-representatives are located in all the principal cities to help industry in the solution of its combustion problems. They will be glad to serve you. Write to 955 Eighth Ave., Michigan City, Indiana.

The HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL MICHIGAN CITY, INDIANA, U.S.A.

ITEMS OF INTEREST

Charles F. Dickinson
has been named manager of the sheet and strip bureau, metallurgical division, Carnegie-Illinois Steel Corporation, Chicago, Illinois. Mr. Dickinson succeeds **Maurice B. Sunderland,** who has been transferred to the Pittsburgh district as metallurgical engineer handling sheet and strip. Mr. Dickinson was formerly assistant to the general superintendent of the Gary Sheet and Tin Division.

Herman J. Hofmann,
who has been assistant open hearth superintendent of Lukens Steel Company, Coatesville, Pennsylvania, since April, 1926, has been promoted to open hearth superintendent succeeding J. D. Walters, resigned. Mr. Hofmann was born in Pittsburgh, Pennsylvania. He entered the employ of Carnegie-Illinois Steel Corporation, Donora, Pennsylvania in 1904 as weighmaster in the transportation department, and subsequently served in various capacities in the rolling mills and operating department. In 1915, Mr. Hofmann joined the Donner Steel Company as turn foreman in the rolling mills. He later transferred to the open hearth department as a helper, ultimately becoming melter foreman, in which position he continued until he came to Lukens in April, 1926.

James C. Hodge
was recently elected vice-president and director of the Wellman Engineering Company, Cleveland, Ohio. Dr. Hodge received his bachelor of science degree from Case School of Applied Science in 1923, majoring in metallurgy. For four years afterwards he was associated with Bennett and Christensen, consulting chemists and metallurgists. He joined the Babcock and Wilcox Company in Barberton, Ohio, in 1927 as a metallurgist, and in 1932 he was appointed chief metallurgist of the Babcock and Wilcox Company. He continued his studies at Harvard between 1931 and 1933, where he obtained his doctorate.

Carl H. Youngdahl
has been appointed assistant superintendent of the power production division at Carnegie-Illinois Steel Corporation's South Works, Chicago, Illinois. Mr. Youngdahl goes to South Works from the Illinois-Iowa Power Company where he had been division engineer in charge of operation, maintenance and construction since 1928.

Charles L. Clarke
was made superintendent of yards and transportation for the South Works of the Carnegie-Illinois Steel Corporation, Chicago, Illinois. Mr. Clarke has been employed at South Works since 1896, when he began as a switchman. He was assistant superintendent of yards and transportation at the time of his appointment.

Russell W. Davy
received the post of construction engineer at Carnegie-Illinois Steel Corporation's South Works, after serving in various capacities in the civil engineering department. During a lapse in service between 1931 and 1937, Mr. Davy was superintendent of engineering at the Chicago Century of Progress and construction engineer for Wilson and Company.

Edwin L. Brown
has been appointed blooming mill superintendent, Gulfsteel division of Republic Steel Corporation, Birmingham, Alabama. He began his career in the steel industry with Marks Manufacturing Company, Indiana Harbor, Indiana, in 1919, now a Youngstown Sheet and Tube Company plant. After serving there in the coke plant, blast furnace and rolling mill departments in various supervisory capacities, he became superintendent of rolling mills for Northwestern Steel and Wire Company, Sterling, Illinois, in 1936.

A. J. Hulse
was made chief engineer of Carnegie-Illinois Steel Corporation's South Chicago Works. Mr. Hulse entered the service of the corporation in 1936 as assistant chief engineer at South Works. He was transferred to the Pittsburgh offices as staff engineer three years later and remained there in that capacity until this time. Before coming to the corporation he served as chief draftsman and assistant chief engineer for Republic Steel Corpora-

CHARLES F. DICKINSON

HERMAN J. HOFMANN

J. C. HODGE

WASTE IS OBVIOUS HERE...

BUT HERE...

SWITCHING TO TYCOL GREEN CAST GREASE REVEALED THAT PLANT SHUT-DOWNS COULD BE AVOIDED

With this plant, lubrication is a matter of the greatest importance and must be given a great deal of thought and care. That is why TYCOL GREEN CAST GREASE has been used for lubrication throughout the plant for the last 2 years. » » » Shut-downs of even a short period during the day cannot be tolerated. If a bearing should heat up and cause a stop it would cost $2.00 per minute, so it is essential that a dependable grease be used. » » » There are over 10,000 ball bearings throughout the plant. During the past two years there have been only 1½ hours delay in production... a lubrication job of which Tide Water is justly proud. » » » This plant has found that by holding down lost production to an absolute minimum, waste can be avoided. This can only be done by having the right kind of grease. *Plant shut-downs cost you money. Don't take chances* when you can be sure of the correct Tycol Grease or Oil "scientifically engineered to fit your needs." The experienced services of Tide Water Engineers are at your disposal.

Regional Offices: Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

TIDE WATER ASSOCIATED OIL COMPANY
TIDE WATER DIVISION, 17 BATTERY PLACE
New York, N. Y.

INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER INDUSTRIAL LUBRICANTS

THERE IS A COMPLETE LINE OF TYCOL LUBRICANTS SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE

tion, chief engineer for H. A. Brassert and Company, assistant chief engineer for Keystone Steel and Wire Company, and proposal engineer for the United Engineering and Foundry Company.

J. H. Morrison
has been appointed general works manager of the Sharon Steel Corporation. Mr. Morrison goes to Sharon from the Pittsburgh Steel Company, where he was general superintendent of the hot mills at the Monessen and Allenport works of that company. He will have charge of the Sharon and Lowellville plants. In 1915 he entered the employ of the Youngstown Iron and Steel Company which later was absorbed by Sharon Steel Hoop Company. In 1936 he went to Monessen as superintendent of the blooming, bar and billet mills of Pittsburgh Steel Company, a year later being also given supervision of the rod mill. In 1938 he became general superintendent of all the hot mills at Monessen and the tube mills at Allenport.

Elmer E. Legge
has been appointed assistant director of research for the American Steel and Wire Company, Cleveland, Ohio. Mr. Legge was transferred from Worcester, Massachusetts, where he was district director of research for the company.

Frank J. Rief
was appointed purchasing agent for the Carnegie-Illinois Steel Corporation. Mr. Rief, who was purchasing agent for the Chicago district, will continue to have his offices in Chicago. Mr. Rief has been connected with the company for 28 years, first at the South Chicago Works and since 1916, in Chicago in the purchasing department.

J. F. Brown
has been named construction engineer for the Chicago district of the Carnegie-Illinois Steel Corporation. Mr. Brown was first employed at the South Chicago Works in 1904 in the civil engineering department. Shortly afterward he became assistant chief civil engineer and in 1906 was appointed chief civil engineer, the position he held until 1930 when he was made construction engineer. Two years later he became acting chief civil engineer and in 1936 was given the post of chief engineer, the position he held until the present time.

Carroll F. Brown
has been appointed superintendent of industrial relations at the Duquesne Works of Carnegie-Illinois Steel Corporation. Mr. Brown was first employed at the Farrell Works of the former American Sheet and Tin Plate Company in 1918. He joined the industrial relations department at Farrell Works in 1936, and has been assistant to vice-president in charge of industrial relations since November, 1939.

Howard C. Brown
became assistant superintendent of yards and transportation at Carnegie-Illinois Steel Corporation's South Works. Mr. Brown was assistant to the superintendent of this department in charge of personnel until the present time.

James E. Sayer,
chief electrician of the Ensley steel works of the Tennessee Coal, Iron and Railroad Company, died recently. Mr. Sayer was 58 years old and had been in the electrical department at the Ensley Works for 39 years. He was widely known in the iron and steel industry.

JAMES E. SAYER

Mr. Sayer was a charter member of the Birmingham District Section of the Association when it was organized in 1919, and served as district chairman in 1928.

Lubricating Engineers ATTENTION

Unless you are thoroughly informed on the subject of oilless lubrication, you may be spending unnecessary money and labor throughout your plant.

METALINE OILLESS BRONZE BEARINGS can be used everywhere. They serve for years without oiling or maintenance in high and low temperature, under water, in inaccessible places, at a wide range of speed and load.

Ask us for the story of METALINE BRONZE BEARINGS and special METALINE fittings. Check their use against your needs and let our engineers assist you in equipping your plant and products with them for trouble-free, economical service.

R. W. RHOADES METALINE CO. Inc.
43 Third Street **Long Island City, N. Y.**

TO HELP GUARD AGAINST COSTLY FUEL WASTE, TWO MORE GREAT MILLS USE Johns-Manville Insulations

WISCONSIN STEEL CO. All hot-blast stoves in this mill are insulated with Superex Blocks or with a combination of Superex Blocks and Sil-O-Cel C-22 Brick. These same two materials are used on open-hearth regenerators, and Sil-O-Cel C-22 Brick is also used on slag pockets.

THERE'S nothing unusual in the insulation methods used by these two Chicago-district mills. As in hundreds of other steel mills and metal-working plants throughout the country, J-M Insulations are used to help keep fuel bills low.

Each Johns-Manville Insulation is made to meet specific structural and operating requirements. And each material can be depended upon for long life and efficient, economical performance on the job.

May we send you details on the complete line of J-M Insulating Materials? Ask for Catalog IN-55A. Johns-Manville, 22 East 40th Street, New York, N. Y.

YOUNGSTOWN SHEET & TUBE CO., Indiana Harbor Works. Open-hearth regenerators are insulated with Superex Blocks. Long recognized as the outstanding high-temperature block insulation, Superex assures years of efficient, dependable service with continued low fuel costs. (Other J-M Insulations are used in the new powerhouse and on steam lines in the new hot-strip mill.)

JM Johns-Manville INDUSTRIAL INSULATIONS

FOR EVERY TEMPERATURE...EVERY SERVICE CONDITION

LESS COST PER TON OF STEEL ROLLED ANGLES

Purchasers of Pittsburgh Rolls have their judgment confirmed year after year by the performances of these rolls under severe operating conditions. Modern Roll technique as practiced by Pittsburgh Rolls insists that Pittsburgh Rolls be the best that can be made for the service required.

PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.

GET THIS NEW CATALOG

Equipment for

TRAVELING ELECTRICAL CONTACT

and

INDUSTRIAL FEEDER SYSTEMS

ETC.

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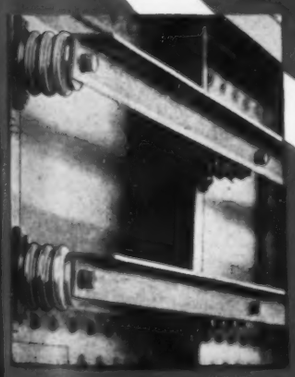
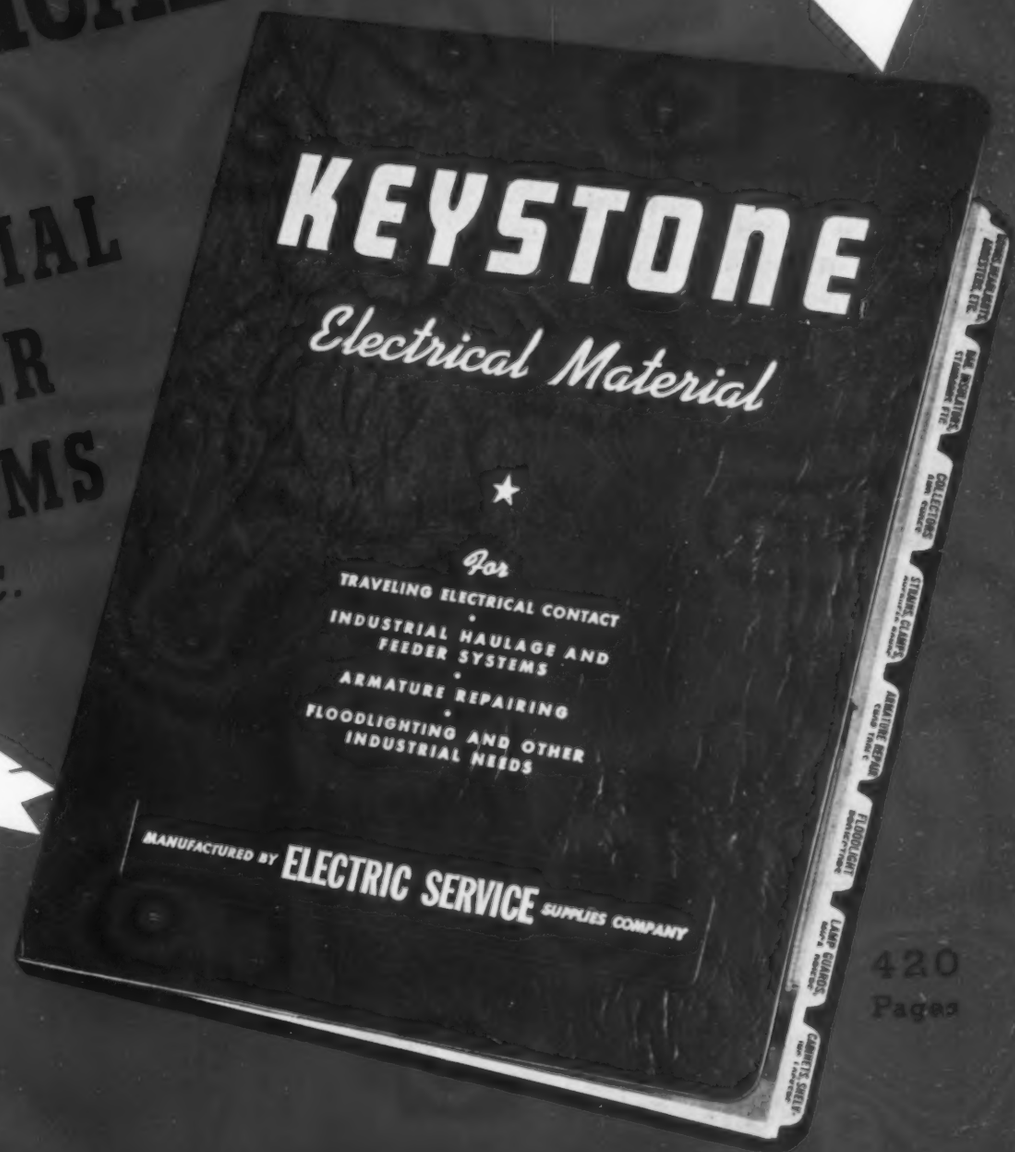
You are cordially invited to visit our Exhibit . . . Spaces 193-194, I & S Exposition, Chicago



Complete contact systems using either rails, angles or wire. All types of collectors and shoes.



MANUFACTURED BY ELECTRIC SERVICE SUPPLIES COMPANY

17th & CAMBRIA STREETS • PHILADELPHIA

No. Canal Street	General Motors Building	50 Church Street	88 Broad Street	Investment Building
Chicago	Detroit	New York	Boston	Pittsburgh

To Help You SPEED UP PRODUCTION

Instruments and controls provide the means whereby the performance of various production units may be checked and their operation closely controlled. They enable the operators to duplicate in daily practice the results obtained under test conditions. Thus a uniform product of consistent high quality is assured at the lowest cost.

Republic Panel Type Automatic Control Unit

Republic Panel Type Control Units are built for the automatic control, at a central point, of furnace pressure, fuel-air ratio, rate of air flow, rate of fuel flow, constant volume and constant pressure. These factors must be controlled individually or in various combinations in the operation of open hearth furnaces, reheating furnaces, annealing furnaces, soaking pits and other types of steel mill furnaces. The unit illustrated to the right is designed for automatic control of fuel-air ratio and furnace pressure.

Each individual factor is controlled by a Republic-Smoot hydraulic type regulator mounted on the rear of the panel, with its power cylinder remotely located at the damper or valve it operates. Supersensitive draft or pressure recorders, flow recorders, fuel-air ratio indicators, etc., are furnished with each panel type control unit as specified.

Designed and built particularly for control of steel mill furnaces, the Republic Panel Type Control Unit offers several important features. It is easy to install because it is one compact unit. It is easy to operate because all operating adjustments, such as resetting of the regulator, manual control, etc., are quickly made from the front of the panel. It is rugged in construction, simple in design and therefore easy to maintain.

Write for Bulletin No. 40-3

Republic-Smoot Regulators

Republic-Smoot Regulators are built for the automatic control of flow, pressure, level, speed and proportion. Above is shown the hydraulic type furnace pressure regulator, as installed on the rear of the Panel Type Control Unit. Regulators for other factors differ only in mechanical details. This regulator is sensitive, fast, powerful, stable, and rugged.

Write for Data Book No. S-13

Multi-Fuel Control

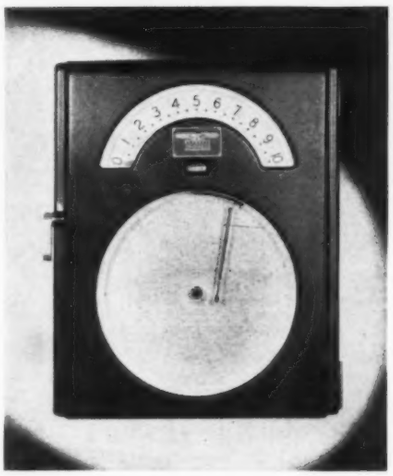
When two or more fuels are to be burned in a furnace, the Republic Panel Type Control Unit operates to supply automatically the correct amount of air for best combustion of the total fuel.

VISIT BOOTH No. 175 AT THE IRON AND STEEL EXPOSITION *and examine this equipment, which will be on display*

AND CUT UNIT COSTS

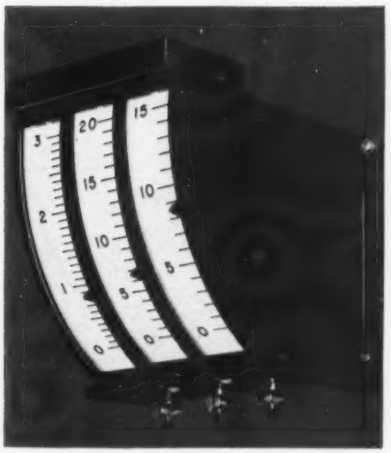
Metering the Flow of Low-Pressure Gas

The Republic ring-balance meter is ideal for measuring low-pressure gases in steel mills, since dirty gas does not affect its operation and it gives full scale readings on differentials as low as 3 in. of water. The mechanical



type is for use where remote registration is not required; with the electrical type, the reading instruments can be located at any distance.

Write for Bulletin No. 110



Supersensitive Draft and Pressure Instruments

Republic offers a special line of supersensitive pressure recorders, developed expressly for steel mill applications, with a total chart range as low as -0.1 to +0.1 in. of water.

For indicating drafts and pressures, the new Republic multi-point gage can be supplied with any scale range and any number of units. All adjustments are accessible from the front.

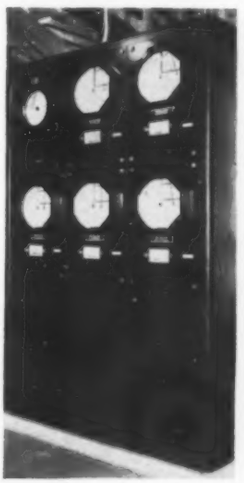
Write for Bulletin No. 801

Metering Distribution Steam and Coke Oven Gas

The Republic distribution meters shown at the right are installed in a large steel mill to measure the flow of coke oven gas to the boilers and the flow of steam to boiler auxiliaries, tin plate mill, hot strip mill, forge shop and steel foundry.

The standard Republic remote reading flow meter forms an ideal means of measuring flow of distribution steam and gas in steel mills, since this meter permits centralization of all recorders at one point for convenient comparison.

Write for Data Book No. 701

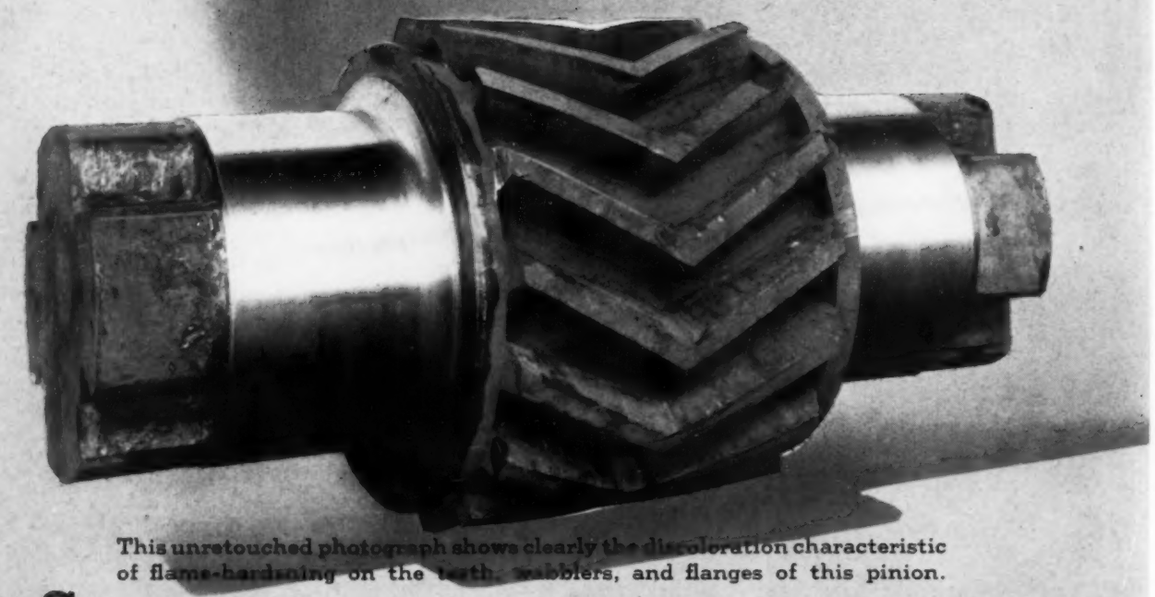


REPUBLIC FLOW METERS CO.

2220 DIVERSEY PKWY. CHICAGO, ILLINOIS

Neloy steel mill pinion

FLAME HARDENED TEETH AND WABBLERS



This unretouched photograph shows clearly the discoloration characteristic of flame-hardening on the teeth, wabblers, and flanges of this pinion.

SPECIAL Steel for special requirements is daily routine at the National-Erie Corporation . . For instance, this large flame-hardened herringbone mill pinion with 16 cast teeth, 6.283" circular pitch, 25" face, 32" pitch diameter, 35.144" outside diameter shaft 6' 1½" over all. Weight unmachined 12,620 lbs. . . Machined, 11,200 lbs. . . Put YOUR problem up to National-Erie . . take advantage of National-Erie's prompt efficient service and the cost savings that go with One Responsibility . . One Control.

NATIONAL-ERIE

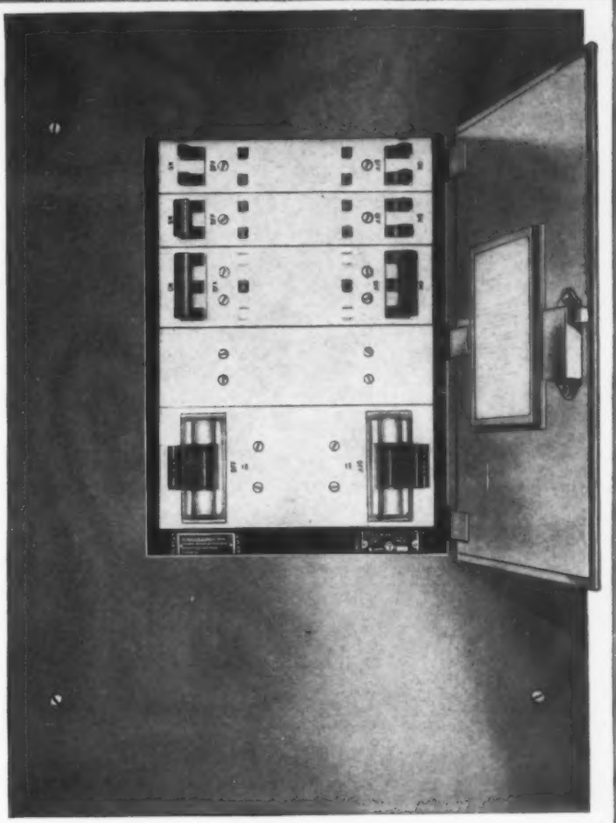
MEMBER OF AGMA

· CORPORATION ·

ERIE, PA., U.S.A.

MEMBER OF SAE

MORE *for your* MONEY
BETTER *for your* PLANT



NEW MULTI-BREAKER POWER PANELS

FULLY AUTOMATIC

OVERLOAD AND SHORT CIRCUIT PROTECTION AT A COST COMPARABLE WITH FUSED EQUIPMENT

Here's a NEW development in application of the time-tested Trumbull Multi-Breaker idea that means LOWER COSTS, GREATER SPEED . . . plus the "last word" in protection against machine "outage"... wherever re-wiring or extension of power circuits is part of Industry's preparedness program.

LOWER COST . . . because these New Multi-Breaker Panels for POWER cost no more than comparable fused equipment.

GREATER SPEED in installation because boxes are standardized, much more compact (only 5¾" deep), carried as stock . . . calling for no special engineering work.

Multi-Breaker Units are interchangeable, can be arranged in many combinations.

BETTER PROTECTION because Multi-Breaker Units have correct precision time-lag, and because service can be restored instantly by the "flip of a switch" when line is cleared. There is nothing to "blow", no replacements, no maintenance.

New Two and Three pole Multi-Breaker Units have COMMON trip.

Available in 15-100 amp. capacity, 125 V-230V. AC single phase and 230V. AC three phase.

NEW MULTI-BREAKER LIGHTING PANELS

Now available with three-pole Multi-Breakers in the mains in more compact boxes (5 ¾" depth) specially suitable for lighting modernization in industrial plants to meet new manufacturing demands.

ESTABLISHED 1899 — THE TRUMBULL ELEC. MFG. CO. — PLAINVILLE CONN. U.S.A. — A GENERAL ELECTRIC ORGANIZATION

Trumbullaids for Steel Engineers

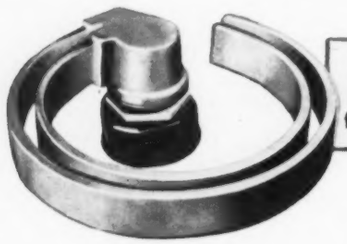
The Trumbull Products shown in these advertisements are illustrated, described and listed in the Trumbullist, in individual circulars and in Trumbull 'Cheer'. Be sure your name is on our lists to receive all of these important TRUMBULLAIDS

NEW YORK - PHILADELPHIA - BOSTON - CHICAGO - DETROIT - LUDLOW, KY. - ATLANTA - NASHVILLE - LOS ANGELES - SAN FRANCISCO - SEATTLE

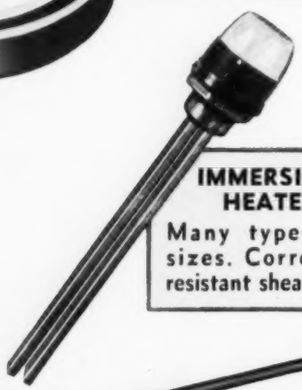
Why ... ELECTRIC HEAT WITH CHROMALOX UNITS IS A PROFITABLE PLANT INVESTMENT

FINSTRIPS
for process work requiring heated air blasts — ovens, dryers, etc.

CARTRIDGE UNITS
for heating machine parts, etc.



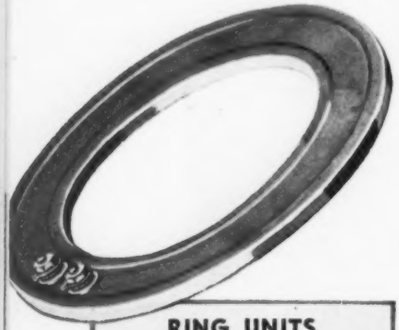
IMMERSION HEATERS
for use in bottom of tanks.



IMMERSION HEATER
Many types and sizes. Corrosion-resistant sheaths.

STRIP HEATERS
Various lengths, straight or curved.

TUBULAR UNITS
Straight, or bent to specified form. Many uses.



RING UNITS
to clamp beneath circular vessels.

BECAUSE — these units can be applied easily to every heating need. No matter what you have to heat — machine part, pipe line, tank, drying oven, etc. —or where its location may be—there are Chromalox units ready to be efficiently applied.

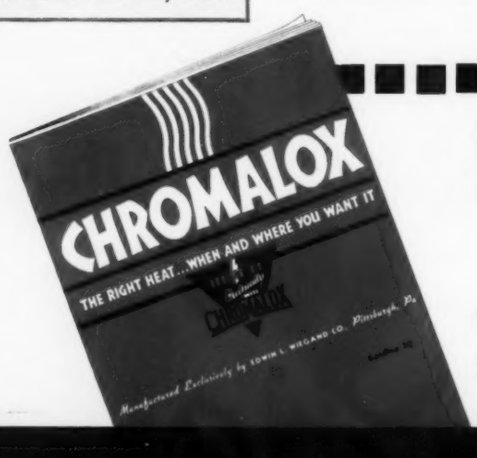
Installation is speedy and simple—wired heat goes anywhere — and without fuss or bother.

And for accurate heat control — you can't beat Chromalox electric heat. Thermostats do the regulating job and insure uniform heat at all times. **This fact alone will eliminate waste and rejections due to overheating or underheating.**

Economy is assured with Chromalox electric heat. A snap of a switch turns your heat on or off. It's a sure way to cut down on wasted heat. And, incidentally, a sure way to speed up production. Also, insurance costs are often lowered by the Chromalox safe installation. Heat with Chromalox is economical heat.

LOOK INTO ELECTRIC HEAT

A copy of the Chomalox Book of Electric Heat — 64 pages of ready reference containing descriptive data on all the different kinds of units, their applications, etc. — is yours for the asking. Just fill in the coupon and attach to your business letterhead.



EDWIN L. WIEGAND COMPANY
7545 Thomas Boulevard
Pittsburgh, Pa.

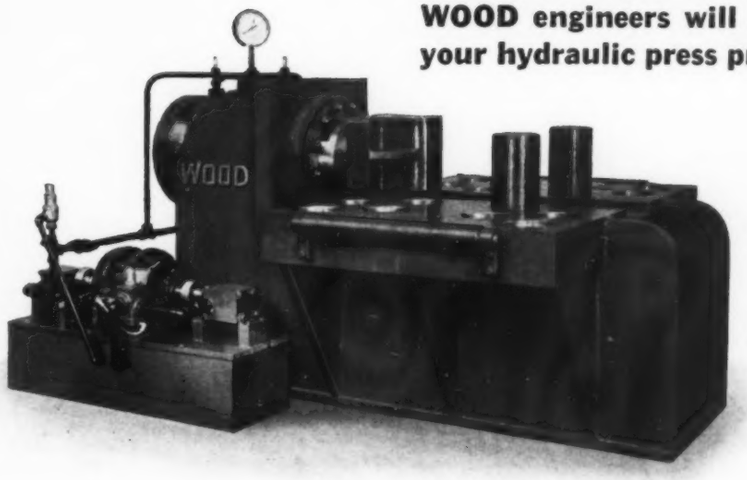
Send me the CHROMALOX BOOK of ELECTRIC HEAT

Name.....

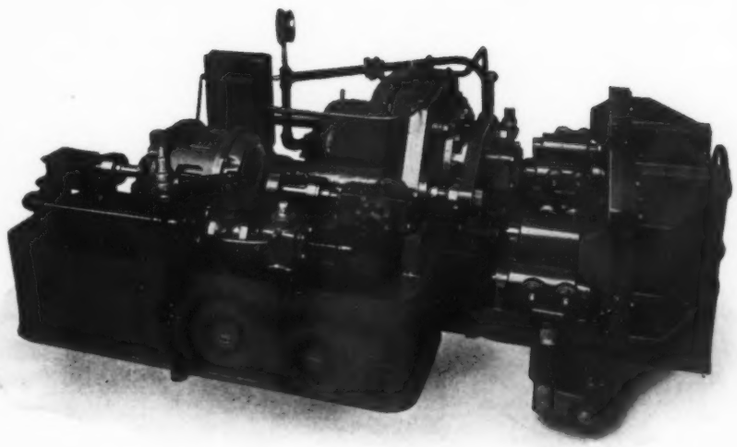
Position.....

HYDRAULIC PRESSES
...FOR THE METAL WORKING INDUSTRIES

In more than fifty years of experience with the design and manufacture of hydraulic presses, practically every industrial need for such equipment has been fully met by WOOD engineers. The broad range of WOOD standard presses is continually being added to by the development of new presses to fill the ever-expanding requirements of American industry. R. D. WOOD engineers will be glad to consult with you on your hydraulic press problems.



This Horizontal Hydraulic Straightening Press, complete with motor-operated high and low pressure pumping equipment, is of 200 ton capacity. The press frame is of welded steel construction carrying a double-acting cast steel cylinder with working stroke of 12″. The table is 52″ x 72″ and is provided with sixteen machined holes for 8″ diameter bending pins. The approach ram speed, at a capacity up to 50 tons, is 25½″ per minute, and at 200 ton capacity, the ram speed is 5¾″ per minute. The return speed is 42½″ per minute. The pumping unit is driven by a 10 H.P., 1200 R.P.M. electric motor.



This 200 ton HydroLectric Shaft Straightener is of unique design. The entire press frame is of heavy welded steel construction and carries individual cast steel main and pullback cylinders. The press table is 73″ long with a 13″ gap between dies. Resistance blocks are movable on the vertical frame face and the table is provided with four heavy stationary rollers for shifting shafts lengthwise, as well as four sets of lifting and turning rollers operated by an air cylinder. An adjustable stop, which will take full press load, is located in the center of the press frame to prevent over-bending. High and low pressure pumps, operated by a 20 H.P. motor, provide a ram speed of 72″ per minute for low pressure closing. The high pressure ram speed is 8.62″ per minute, while the return or opening speed is 130″ per minute.

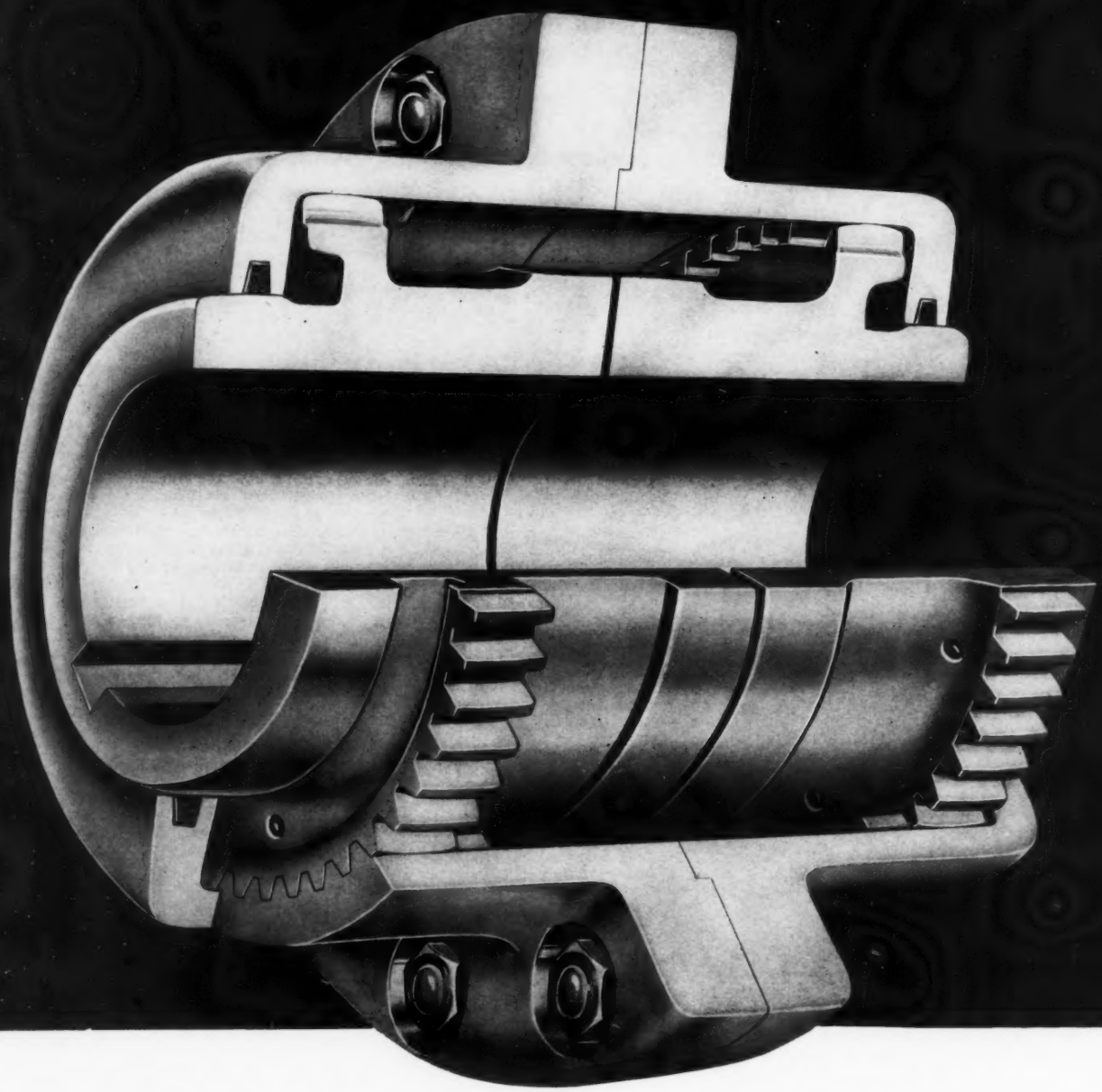
...HYDRAULIC PRESSES AND VALVES FOR EVERY PURPOSE

ESTABLISHED 1803

R.D. Wood Co.

PHILADELPHIA, PA.

POOLE

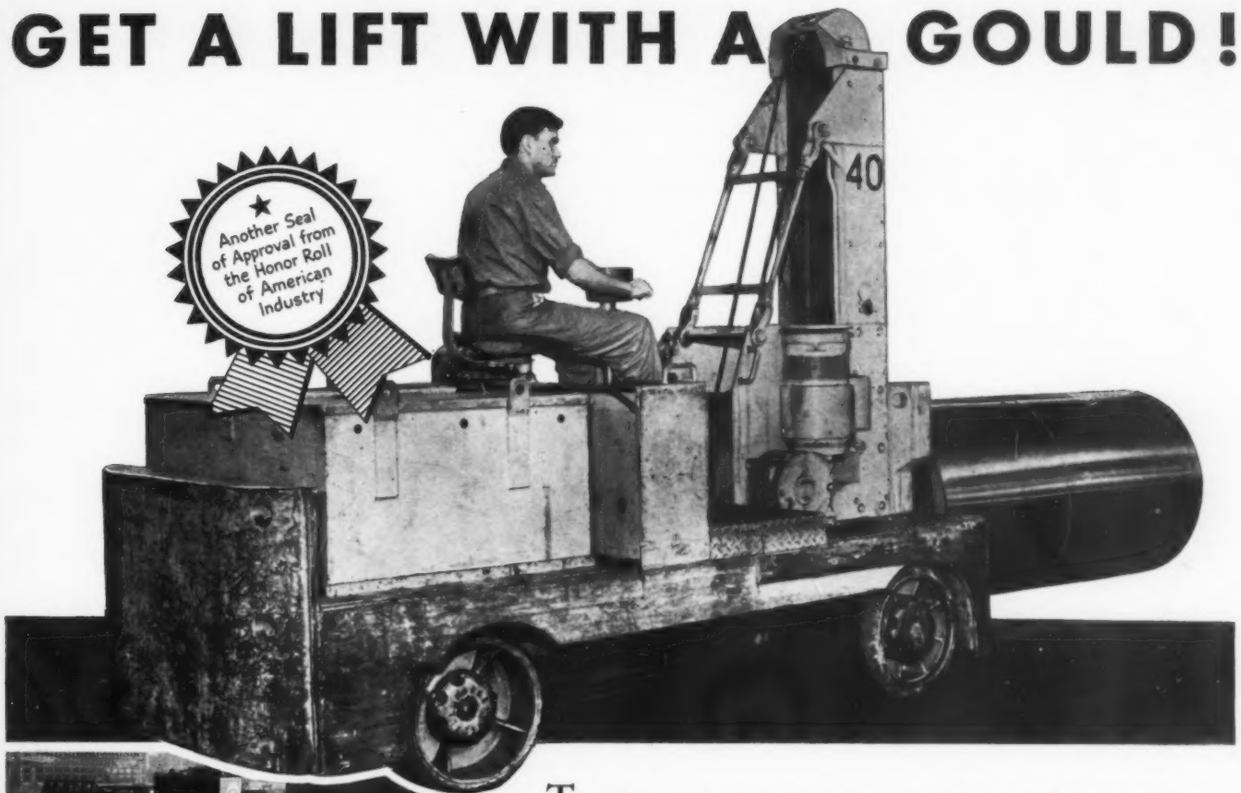


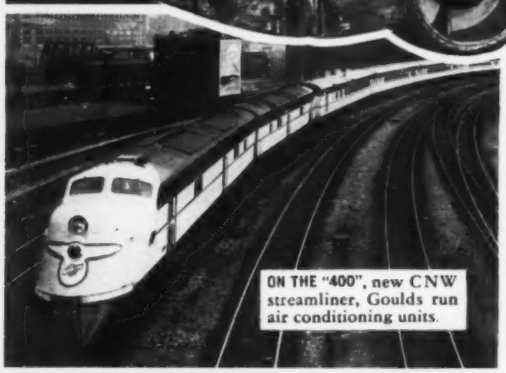
A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

GET A LIFT WITH A GOULD!



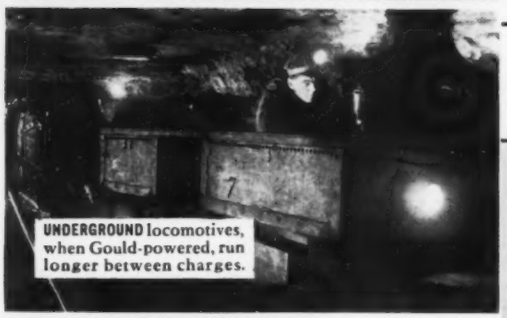


ON THE "400", new CNW streamliner, Goulds run air conditioning units.

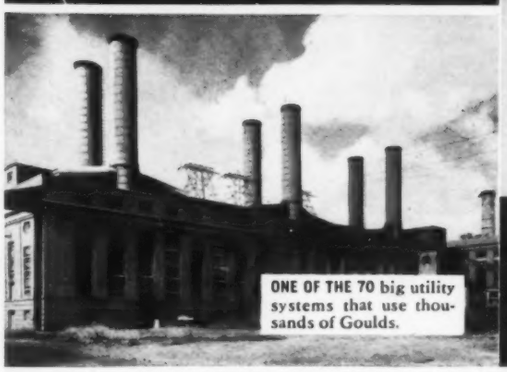
The industrial truck is the modern work horse of industry. To it go the tough jobs of production—lifting the dead weight of steel, holding it, moving it, putting it down again—shunting freight cars, loading them, shunting them again. Tough jobs call for a tough battery—one with ample margins of power and stamina.

That's why Goulds operate the trucks owned by the American Hoist & Derrick Company of St. Paul, makers of electric winches, road building machinery and the famous Crosby clip. That's why you will find Gould batteries in every industry, doing the hundreds of tasks that demand extra power, longer life, greater dependability.

VISIT US AT BOOTH 46
SEPTEMBER 24-27 STEVENS HOTEL



UNDERGROUND locomotives, when Gould-powered, run longer between charges.



ONE OF THE 70 big utility systems that use thousands of Goulds.

For Over 40 Years Gould Has Made Batteries for Every Industrial Application!

GOULD PLANTE: *Guaranteed 14 years* in floating service. Maximum life with highest sustained capacity under all operating conditions made possible by exclusive one-piece pure lead spun plate process.

GOULD KATHANODE: *Guaranteed from 4 to 12 years.* Spun Glass construction provides long life, light weight and high capacity at low operating cost. For all motive power and railroad applications.

GOULD DREADNAUGHT *Guaranteed from 2 to 8 years.* Maximum capacity and long life when pasted plate construction for low initial cost is of primary importance.

NOTE: KATHANODE and DREADNAUGHT batteries are available in either Glass Jar or Hard Rubber construction.

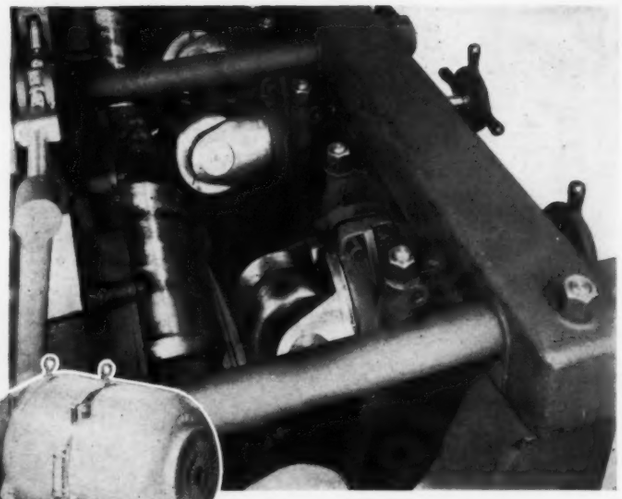
FREE illustrated manuals describing any of these exclusive Gould constructions are yours upon request. Write: Gould Storage Battery Corporation, Depew, N. Y.

GOULD

KANE & ROACH

Straighteners

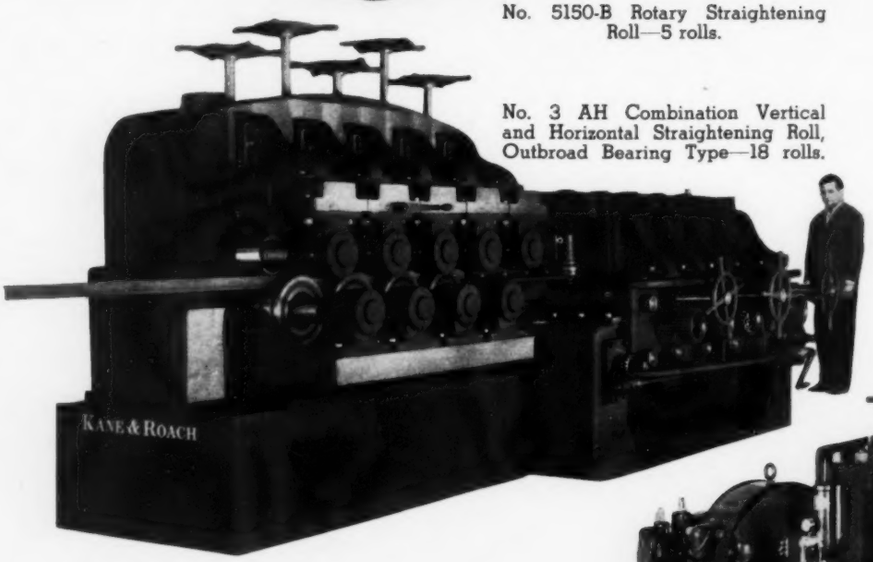
No. 5150-B Rotary Straightening Roll—5 rolls.



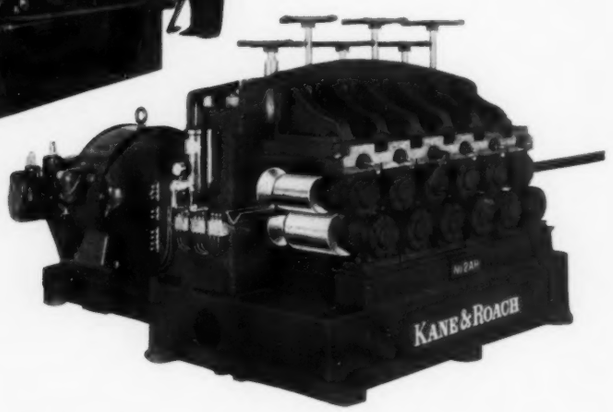
Vibration and roll overhang are largely eliminated by clamping roll mountings close up to the work, K & R patent pending

The three straighteners shown are but a portion of the complete Kane and Roach line of Straightening Equipment built to meet every size and requirement.

No. 3 AH Combination Vertical and Horizontal Straightening Roll, Outbroad Bearing Type—18 rolls.



No. 2 AH Horizontal Shaft Straightening Machine, Outboard Bearing Type—12 rolls.



We also manufacture a complete line of Bending Rolls, Cold Roll Forming Machines, Gang Slitters, Edging Machines, Wire Crimpers and Bulldozers.

KANE & ROACH

INCORPORATED

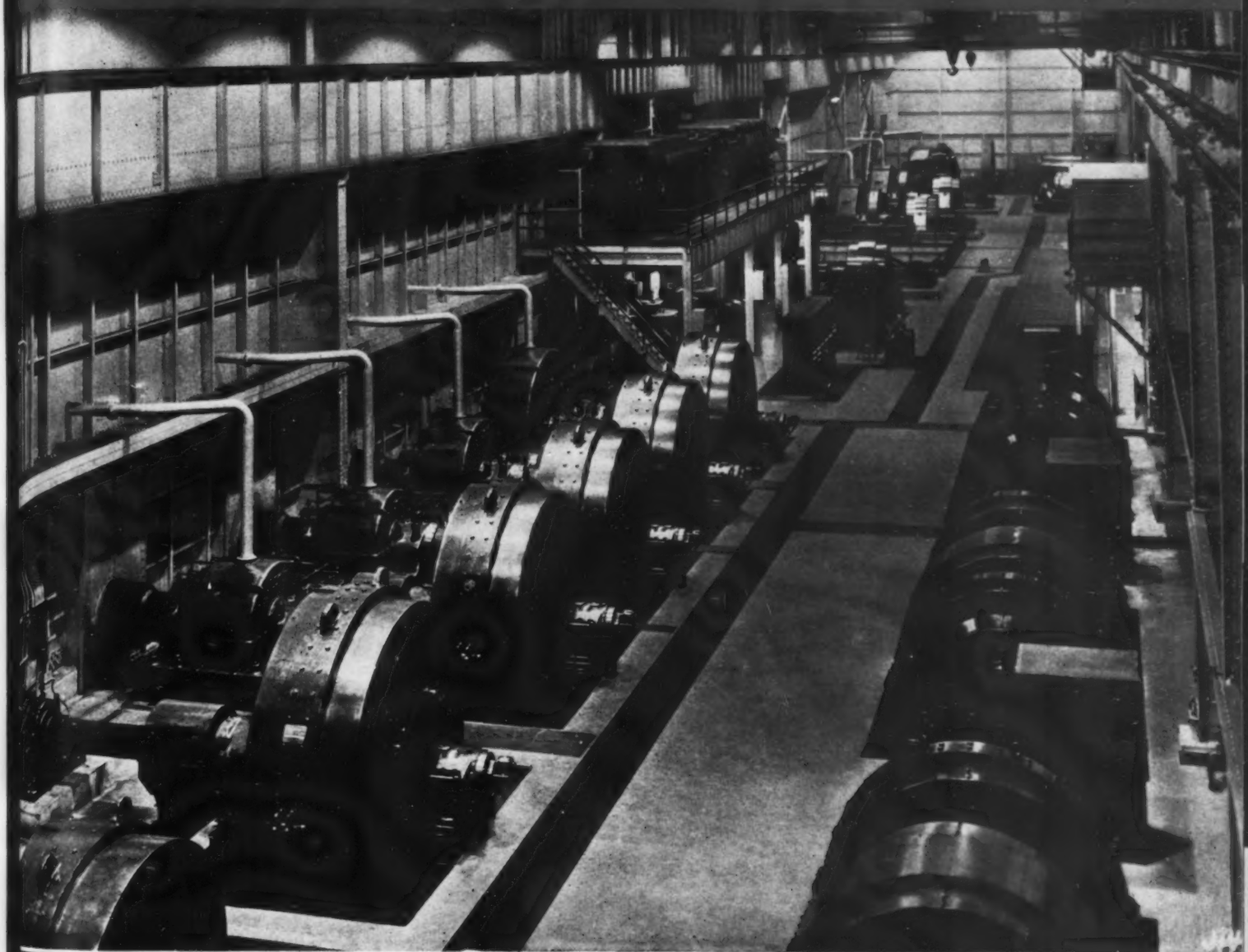
Syracuse, New York

Established 1887

MORGANITE

for

Superior Performance



MORGANITE

BRUSH COMPANY, Inc.

TRADE MARK

LONG ISLAND CITY, NEW YORK

BRANCH OFFICE: CHICAGO, ILL.

P-G STEEL MILL RESISTORS

BUILT WITH
INDESTRUCTIBLE

STEEL AND MICA

Give a New Conception of Continuous Service

P-G Resistance Grids are punched from corrosion resistant chromium alloy steel sheets and are high in resistance value with the ability to retain mechanical strength under the most severe conditions. When combined with high grade mica insulation and held together by P-G patented floating bolt construction, a better standard of resistor performance is the logical result.

SEE THIS RESISTOR AT BOOTH No. 186

The Iron and Steel Exposition

"The Resistor you can Install and Forget"

P-G

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI, OHIO

These NEW COLT MOTOR CONTROLS ..are already Going Places!

They're Built To Do a Job for Industry

After years of research and experiment . . . this new line of Colt Motor Controls is now ready to step into today's industrial program . . . and do an outstanding job.

The line includes Manual and Automatic Starters — Contactors —Combinations and Two-Speed and Reversing Starters.

Every one of them boasts a rugged, simple mechanism, attractive cabinets, and operating features that assure efficiency, economy and long life.

Send for the three booklets shown below . . . ask for Bulletins 404, 504 and 501.

Manufactured by a World Famous Organization

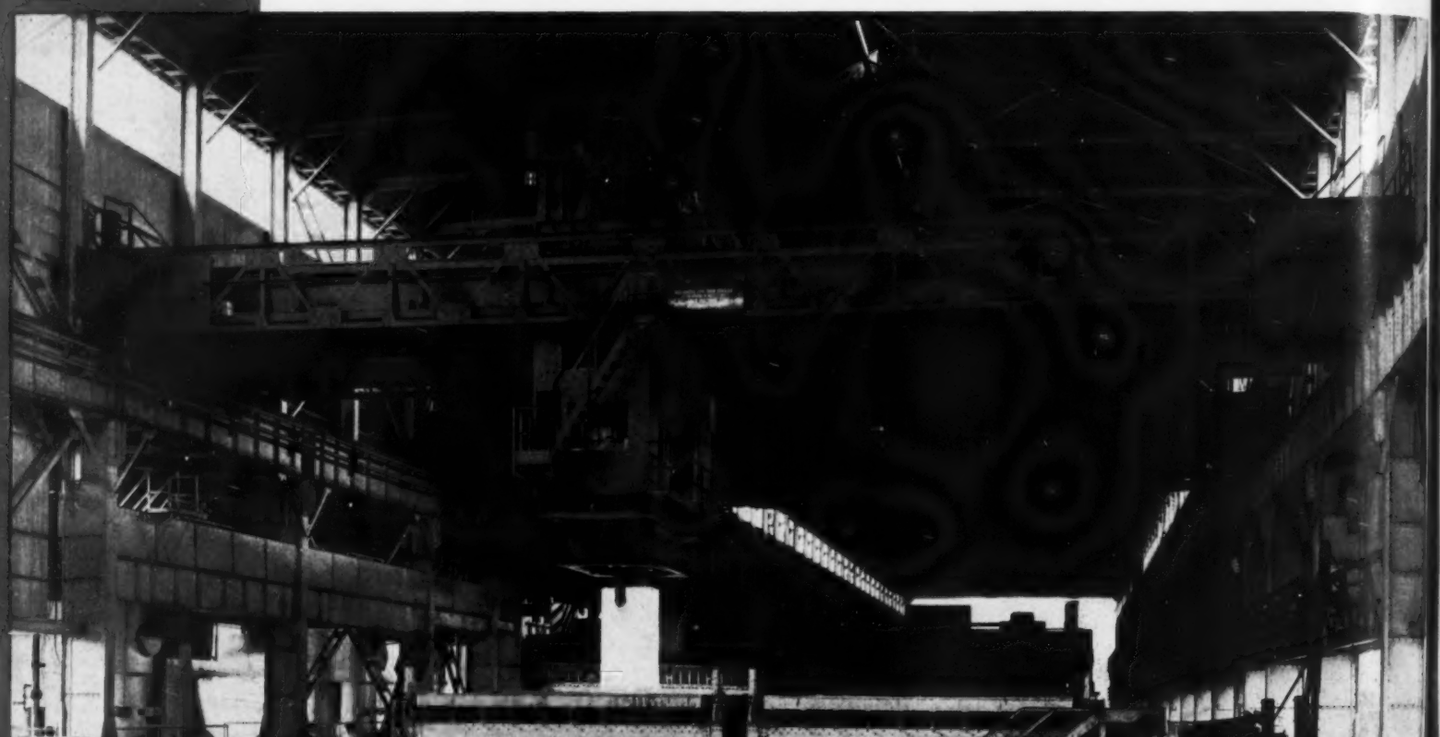
COLT'S PATENT FIRE ARMS MFG. CO.
Electrical Division — Hartford, Conn.

COLT MOTOR CONTROLS

Manual Motor Starters · Manual Reversing and 2-Speed Starters · Magnetic Contactors and Relays · Magnetic Motor Starters · Magnetic Reversing Contactors and Starters · Magnetic 2-Speed Starters · Combination Starters.

Alliance

"LARGEST BUILDERS OF THE WORLD'S LARGEST CRANES"



Alliance 20 Ton Pit Crane

20 Ton 86'-0" Span Low Type Soaking Pit Crane

The Alliance Machine Company designs and builds—

- LADLE CRANES
- INGOT STRIPPERS
- SOAKING PIT CRANES
- STANDARD CRANES
- GANTRY CRANES
- ORE AND COAL BRIDGES
- OPEN HEARTH CHARGING MACHINES
- SLAB & BILLET CHARGING and DRAWING MACHINES
- CAR DUMPERS
- FORGING MANIPULATORS
- BOARD AND STEAM DROP HAMMERS
- COAL PIER EQUIPMENT
- ROLLING MILL MACHINERY and SPECIAL MACHINERY—*all to your individual requirements.*

THE ALLIANCE MACHINE COMPANY

ALLIANCE . . . . OHIO

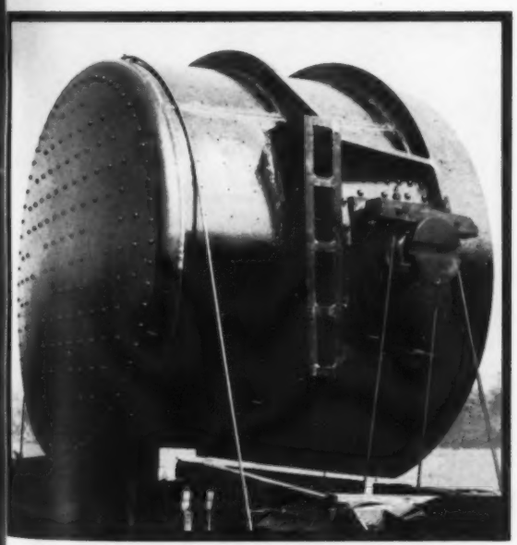
TREADWELL

Cold Rolling Mills
Tables and Transfers
Hot Beds
Coilers
Shears
Merchant Mills
Steel and Iron Castings

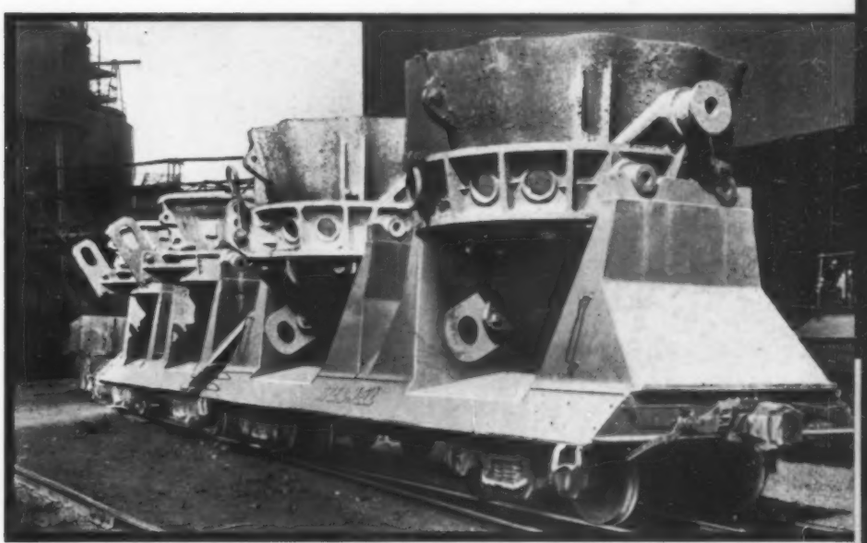
Hot Coiler for Wide Strip Mill

Welded Ladles
Charging Boxes
Ingot Mold Cars
Stacks
Galvanizing Kettles
Gas Piping
Stand Pipes
General Plate Work

Mixer Type Hot Metal Cars
Steam, Air or Motor Dump Cinder Cars for Blast Furnace or Open Hearth Use
Single, Double or Triple Pot Crane Dump Cinder Cars
Scrap Charging Cars



160 Ton Welded Open Hearth Ladle



900 Cu. Ft. Twin Pot Crane Dump Cinder Car

M. H. Treadwell Co., Inc.
New York, N. Y.

208 South LaSalle Street
Chicaga, Ill.

Treadwell Engineering Co.
Easton, Pa.

SALES OFFICES
2113 Farmers Bank Building
Pittsburgh, Pa.

Treadwell Construction Co.
Midland, Pa.

140 Cedar Street
New York, N. Y.

Now Available—
"3C" Bulletin 100, Heavy Duty Push Buttons in Dust Tight and Water Tight Cases
START
STOP
DUST TIGHT IN ACCORDANCE WITH NEMA DEFINITION IC 50-28
WATER TIGHT IN ACCORDANCE WITH NEMA DEFINITION IC 50-43
1, 2, 3, and 4 UNIT STATIONS AVAILABLE!

● Inside this sturdy, weatherproof, cast aluminum case you'll find the same husky mechanism used in all "3C" Type "D" Heavy Duty Push Buttons. Silver-to-Silver Button Type Double Break Contacts • • • All insulating parts Bakelite • • • large electrical and mechanical clearances • • • Push Button travel not limited by contacts • • • all parts removable and replaceable with a screwdriver • • • All these are features of Type "D" Heavy Duty Push Buttons. ● And what an enclosure! Cast aluminum with evenly machined surfaces between cover and base • • • exterior operating mechanism and stuffing box mounted in the cover • • • small nut on operating shaft for adjustment of stuffing box • • • drive screws hold gasket firmly to cover • • • gasket can't buckle • • • can't come loose, can't get lost • • • gasket holes always in perfect alignment with holes in cover and base. Pilot lights with color caps for interchangeable mounting with units are available.

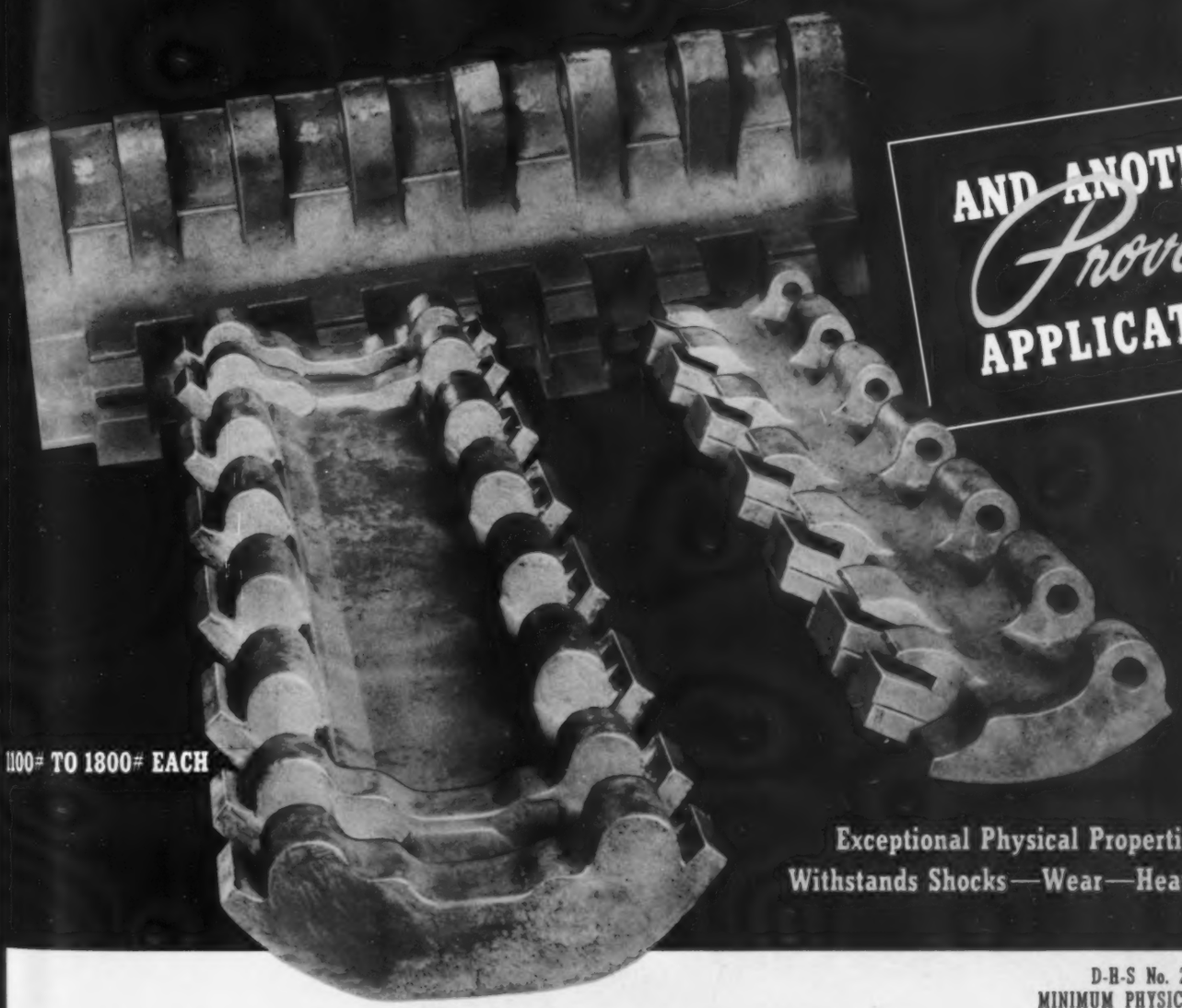
WRITE FOR FOLDER GIVING COMPLETE DETAILS

OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

Reel Segments



AND ANOTHER *Proven* APPLICATION

1100# TO 1800# EACH

Exceptional Physical Properties—
Withstands Shocks—Wear—Heavy Loads

D-H-S BRONZE

DUCTILITY · HARDNESS · STRENGTH

LONGER LIFE • LOWER COST

CASTINGS AND FORGINGS

D-H-S No. 2 BRONZE
MINIMUM PHYSICAL PROPERTIES

Ultimate Tensile Strength (lbs. per square inch)	115,000
Yield Point (lbs. per square inch)	90,000
Elastic Limit (lbs. per square inch)	55,000
Elongation—per cent in two inches	12
Reduction of Area—per cent	12
Brinell Hardness No.	225
Permanent Set under 100,000 lbs. per square inch	.020

Note: Recommended for applications where lineal contact speeds do not exceed 250 feet per minute.

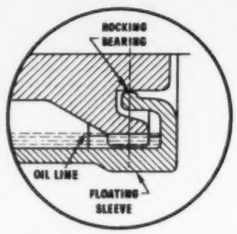
KOPPERS COMPANY · BARTLETT HAYWARD DIVISION · BALTIMORE, MD.

OTHER KOPPERS PRODUCTS: Coal . . Coke . . Coal Handling and Preparation Plants and Equipment . . Coke Oven Plants . . Gas Holders and Equipment . . Purification Systems . . Materials Handling Systems . . Treated Timber . . Waterproofing . . Lumino and Bituminous Base Paints . . Built-up Roofs . . American Hammered Piston Rings and Packing . . Hot Metal Transfer Cars . . Ships, Barges and Dry-Docking Facilities . . Fast's Self-aligning Couplings.

a KOPPERS product

FAST'S COUPLINGS

Self aligning



This sectional view shows Fast's construction. The load-carrying surfaces are protected against wear by a positive film of oil. This oil is kept permanently clean by the rocking bearings which make precise metal-to-metal contact and are in the one position where they form permanent dust and moisture proof seals. These vital features are found only in "Fast's."

Engineers who check costs and results know that experiments with untried couplings are too costly to risk. Fast's Couplings have been proven "on the job" for many years. To eliminate gambles and avoid operating troubles—specify *genuine* Fast's Couplings on the machinery you purchase.

KOPPERS COMPANY · BARTLETT HAYWARD DIVISION · BALTIMORE, MARYLAND

● **OTHER KOPPERS PRODUCTS FOR THE STEEL FIELD:** Coal . . . Coke . . . Coal Handling and Preparation Plants and Equipment . . . Coke Oven Plants . . . Gas Holders and Equipment . . . Purification Systems . . . Materials Handling Systems . . . Treated Timber . . . Waterproofing . . . Lumino and Bituminous Base Paints . . . Built-up Roofs . . . D-H-S Bronze . . . American Hammered Piston Rings and Packing . . . Hot Metal Transfer Cars . . . Ships, Barges and Dry-Docking Facilities.

a KOPPERS product

Weirton Steel DUPLICATES THE LARGEST HOT PROCESS SOFTENER in the World

THE largest single unit hot process softener in the world was the Cochrane 160,000 gal. per hr. Softener installed by the Weirton Steel Co., at Weirton, W. Va., in 1926, to prepare 100% make-up water for 900 lbs. pressure boilers.

Now, after fourteen years of successful operation, Weirton Steel Co., has ordered a duplicate softener at the same huge dimensions and capacity to be installed beside and to operate in parallel with the present softener. The boiler plant extension for which this softener is designed is being erected at the left of the present high-pressure plant and the new softener will be installed to the right of the present unit. In addition to the softener, a new Cochrane 600,000 lb./hr. Deaerator is being installed to deaerate the boiler feed. The great record of Cochrane Softeners and Deaerators thus marches on to even higher records of achievement.

The Cochrane Hot Process Softener below, of 160,000 GPH capacity was installed in 1926.

A duplicate of the Cochrane Hot Process Softener shown at the left will be erected in the space indicated here. Capacity will be 160,000 GPH, with a two-hour sedimentation tank and a number of modern Cochrane improvements incorporated such as a stirring mechanism to aid flocculation and better distribution of chemicals. The filters also will be arranged with simplified valve nests which permits back wash with filtered water.

COCHRANE CORPORATION • **3133 NORTH 17th STREET** • **PHILADELPHIA, PENNA.**

COCHRANE

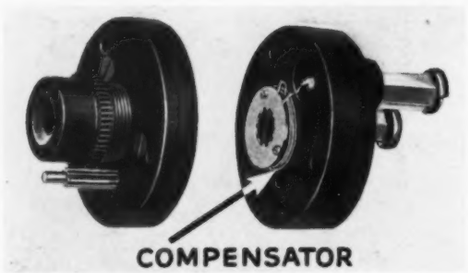
WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS

New RADIAMATIC

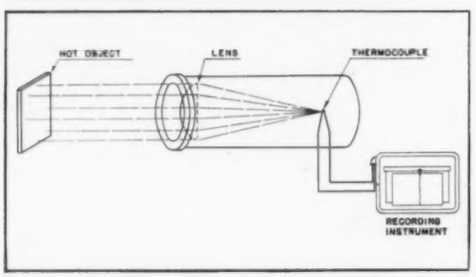
COMPENSATED *for* AMBIENT TEMPERATURES

Radiamatic sighted on roof through hole in furnace back wall. Potentiometer continuously indicates and records roof temperature.

RADIAMATIC DETECTOR



COMPENSATOR



PRINCIPLE OF OPERATION

Brown Radiamatic will be on display at the National Metal Exposition, Cleveland, Ohio, Booth F4, October 21st to 25th, 1940 and The Iron and Steel Exposition, Chicago, Booth 66, September 24th to 27th, 1940.

Satisfies All Demands

Convenient to operate and universal in applications for the measurement and control of temperatures where thermocouples are impractical and unreliable. The new Brown Radiamatic Pyrometer (made in America) is designed to operate under severe conditions of temperature, vibration, etc.

Completely self-contained and compensated for ambient temperature errors, the Radiamatic detector is sighted on the hot object, moving or still, and continuously measures the desired temperature of the material itself.

The Radiamatic consists essentially of a heat-resisting lens, a compensator and a thermopile. The heat radiated from the hot object falls on the lens and is focused on the thermopile which generates an E.M.F. proportional to the true temperature. The compensator corrects for ambient temperature fluctuations surrounding the detector — hence the desired E.M.F. alone developed by the thermopile is translated into degrees of temperature and is continuously indicated, recorded or controlled by the potentiometer.

The Brown Radiamatic is ruggedly constructed, built to withstand vibration — accuracy is unaffected by dust, dirt, fumes and corrosive atmospheres. Easily installed complete with all accessories for mounting.

Use the Radiamatic for those applications where vibration breaks thermocouples — furnaces move or rotate — work moves or thermocouples cannot be installed — temperature is above thermocouple range — maintenance of platinum thermocouples is costly.

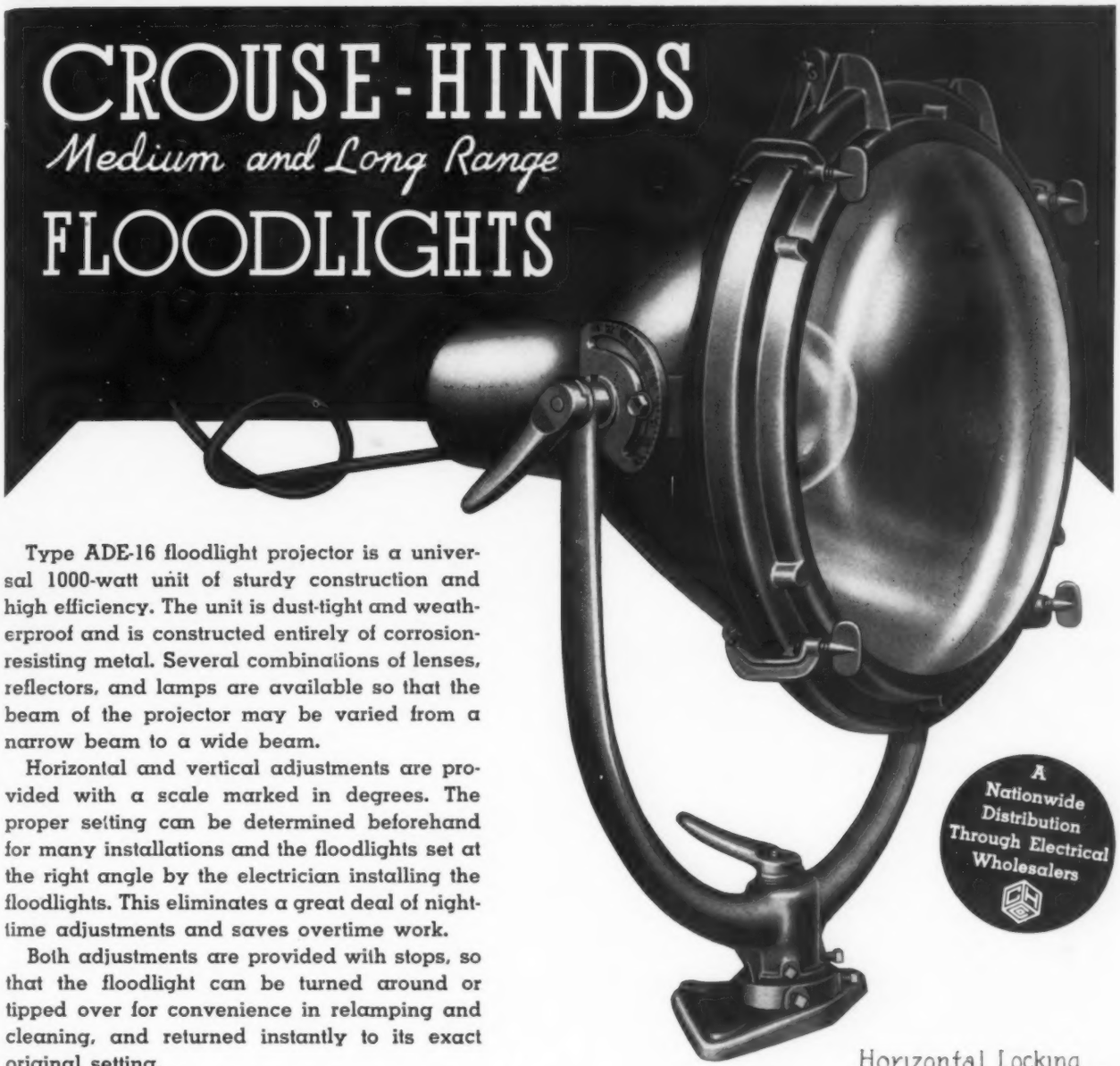
For information write THE BROWN INSTRUMENT COMPANY, *a division of Minneapolis-Honeywell Regulator Co*, 4464 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street — Amsterdam-C, Holland: Wijdesteeg 4 — England: Wadsworth Road, Perivale, Middlesex — Stockholm, Sweden: Nybrokajen 7.

BROWN RADIAMATIC PYROMETER

CROUSE-HINDS

Medium and Long Range

FLOODLIGHTS



Type ADE-16 floodlight projector is a universal 1000-watt unit of sturdy construction and high efficiency. The unit is dust-tight and weatherproof and is constructed entirely of corrosion-resisting metal. Several combinations of lenses, reflectors, and lamps are available so that the beam of the projector may be varied from a narrow beam to a wide beam.

Horizontal and vertical adjustments are provided with a scale marked in degrees. The proper setting can be determined beforehand for many installations and the floodlights set at the right angle by the electrician installing the floodlights. This eliminates a great deal of nighttime adjustments and saves overtime work.

Both adjustments are provided with stops, so that the floodlight can be turned around or tipped over for convenience in relamping and cleaning, and returned instantly to its exact original setting.

Similar Crouse-Hinds floodlight projectors are available in sizes ranging from 200 to 2000 watts.

They can be provided with various types of mountings so that the proper base may be selected for each particular installation.

A Crouse-Hinds representative will gladly assist in planning a solution to difficult and unusual lighting problems.

Send for Floodlight Catalog No. 316.

A Nationwide Distribution Through Electrical Wholesalers

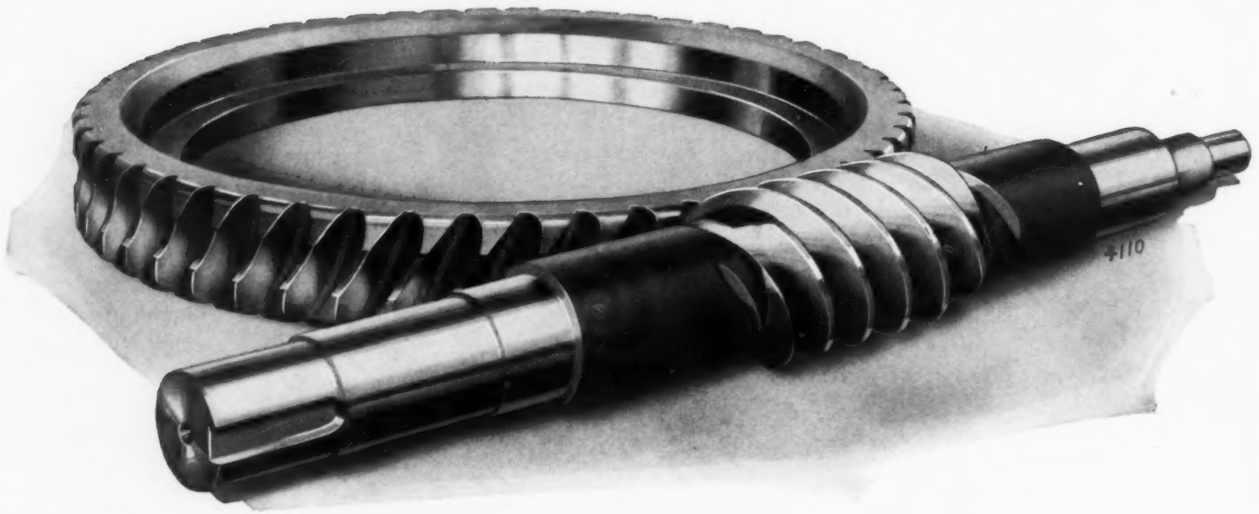
CROUSE-HINDS COMPANY

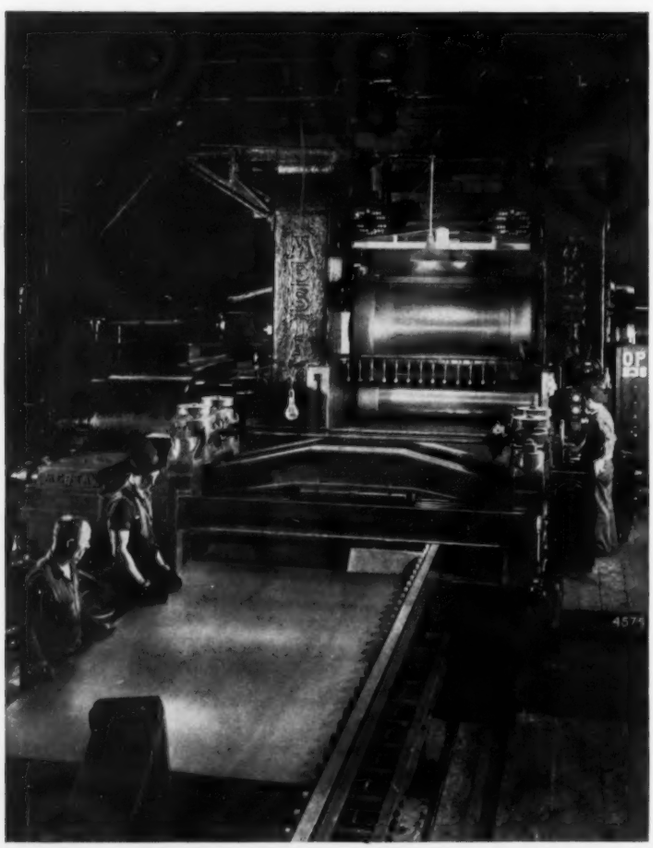
SYRACUSE, N. Y., U. S. A.

Sales Offices: Atlanta Boston Chicago Cincinnati Cleveland Dallas Detroit Houston Kansas City Los Angeles Milwaukee Minneapolis New York Philadelphia Pittsburgh San Francisco Seattle St. Louis Washington

CH661

For QUALITY PRODUCTS





use QUALITY PARTS

THE Pittsburgh Works of the Jones & Laughlin Company was designed to produce highest quality hot and cold rolled strip and sheet steel. The photograph shows a roller leveler in operation at the delivery end of a Mesta four-high temper mill.

The screw downs are operated by

DE LAVAL WORM GEAR SETS

which provide great force and precision in small space for the adjustment of the rolls.

Data on worm gears and their applications will be supplied by our engineers, upon request.

W-1122

DE LAVAL *Steam Turbine Co.*
TRENTON, N.J.

MANUFACTURERS OF TURBINES - STEAM, HYDRAULIC; PUMPS - CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING; CENTRIFUGAL BLOWERS and COMPRESSORS; GEARS - WORM, HELICAL and FLEXIBLE COUPLINGS

DROP HAMMERS

1,000 LBS. TO 16,000 LBS. CAPACITY

FORGING HAMMERS

150 LBS. TO 40,000 LBS. CAPACITY

FORGING PRESSES

300 TONS TO 6,000 TONS CAPACITY

DESIGNERS • MANUFACTURERS
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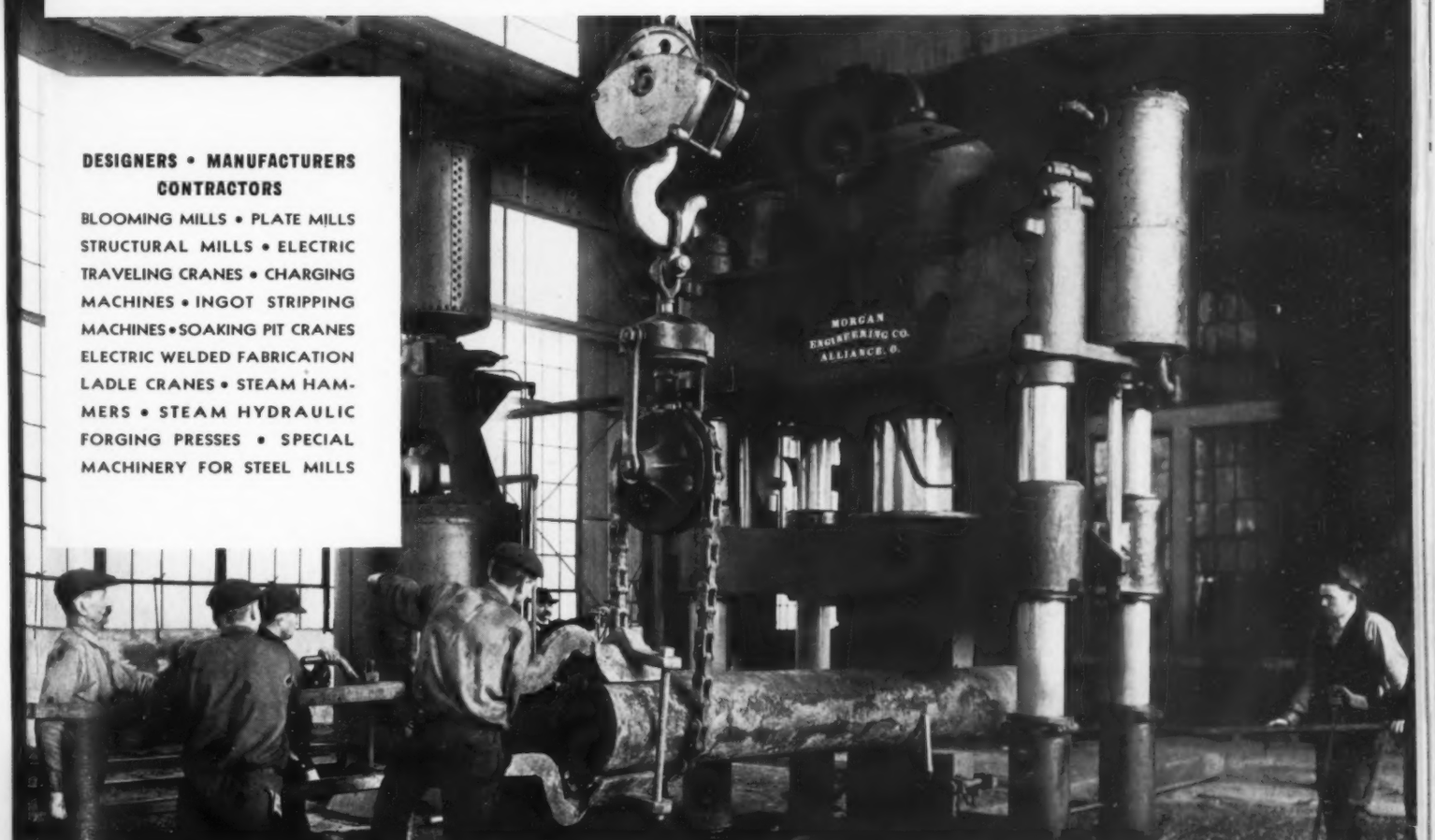
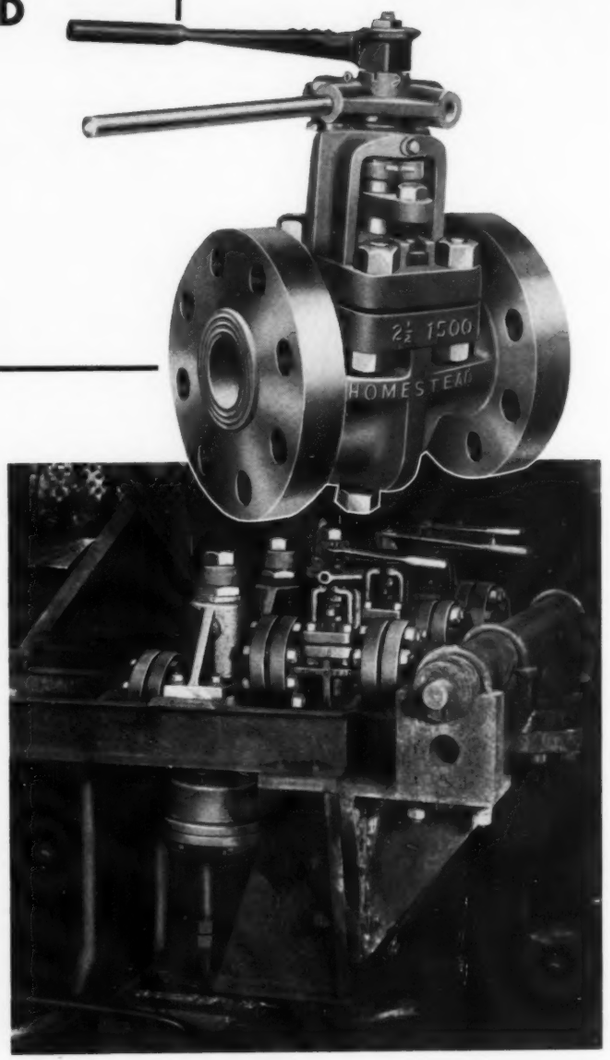
BLOOMING MILLS • PLATE MILLS
STRUCTURAL MILLS • ELECTRIC
TRAVELING CRANES • CHARGING
MACHINES • INGOT STRIPPING
MACHINES • SOAKING PIT CRANES
ELECTRIC WELDED FABRICATION
LADLE CRANES • STEAM HAM-
MERS • STEAM HYDRAULIC
FORGING PRESSES • SPECIAL
MACHINERY FOR STEEL MILLS



THE MORGAN *Engineering Co.*

A L L I A N C E , O H I O

Your Valve troubles END with HOMESTEAD *Lever-Seald* PLUG VALVES!



YOU can bet on these six "built-in" features of Homestead Lever-Seald Valves to put a quick stop to valve troubles:

1. *Quarter-turn* fully opens or closes.
2. *Instant, easy operation* by powerful leverage. Cannot stick.
3. *No leakage.* Deep stuffing box. *Minimum upkeep.*
4. *Long, low-cost service.* Seating surfaces protected in open and closed positions.
5. *Positive leakless seal* . . . no lubrication required.
6. *Minimum pressure drop* . . . straight line flow.

Installation of 2½" Lever-Seald Homestead Valves on 1500 pounds W.P. hydraulic stop service, in a large Mid-Western Steel Mill. Direct air operated Homestead Protected Seat Spray Valves for the descaling system are also shown.

Homestead Lever-Seald Valves are made in a wide range of sizes and types, and cast in steel, iron, stainless steel, bronze, Monel, Ni-Resist, and other metals suitable for the specific temperature, fluid, and pressure conditions.

Choose the proper type for your needs from Reference Book No. 38 (copy sent free on request). Then specity or order Homestead Lever-Seald Valves for your next job.

☆ *Visit us at Booth No. 228, Iron and Steel Exposition.*

HOMESTEAD VALVE MFG. CO., BOX 21, CORAOPOLIS, PA.

HOMESTEAD VALVES

QUARTER-TURN VALVES:
STRAIGHT-WAY
THREE-WAY
FOUR-WAY
LUBRICATED TYPE
LIFT-TYPE PLUG

PROTECTED-SEAT VALVES:
HYDRAULIC (B. & O. PAT.) OPERATING
REMOTE CONTROL
HYDRAULIC DESCALING
ROSS AIR SHUT-OFF VALVES
HOVALCO BLOW-OFF VALVES

5 big features *make this* Industrial Advertising Conference *a "must" for you!*

"CLINICS" . . . informal group discussions of "Tying in Advertising with Selling," "Getting Salesmen's Cooperation," "Direct Mail," "Measuring Results," "Market Information," "Copy Testing," "Programs that Management Will Approve," "Layout, Copy and Illustration," "Allocation of Budgets" and other problems. *Inside information on successful methods and campaigns,* and an opportunity to have *your questions answered.*

ADVERTISING DISPLAY . . . direct mail, publication ads, sales literature and company magazines that are being used by hundreds of large and small industrial advertisers. Awards for outstanding work. *Stimulating source of new ideas.*

GENERAL SESSIONS . . . led by national authorities, on current industrial advertising and sales developments. Enable you to *keep abreast of trends that affect your business.*

RELAXATION . . . annual banquet, show, and dance . . . publishers' reception . . . opportunity to visit friends . . . program for wives, including trip through Ford's Greenfield Village.

CUSTOMER CONTACTS . . . you can visit important customers in Detroit plants, see your company's products being used, get first-hand reactions to advertising, take photographs for use in your 1941 advertising and sales promotion.

GOING TO BUY A NEW CAR? — You can save money by taking delivery in Detroit and driving it home.

Markets and selling conditions are changing. But profitable sales await those alert companies who study the trends and improve their practices. At this Conference you will get new ideas that will help you do a better, more efficient job, and make your 1941 advertising and sales promotion program more effective.

All Industrial Advertising and Sales Executives Are Invited

If your company sells to other business organizations, rather than to the general public . . . you will find this Conference devoted 100% to ***your*** problems. You are invited to attend, whether or not you are a member of N. I. A. A.

Write now for program and advance registration form, to Mr. Henry Doering, Registration Chairman, Truscon Laboratories, Inc.; Box 69, Milwaukee Junction P. O., Detroit, Mich.

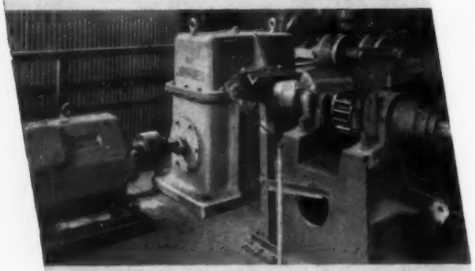
Advance Registration Saves You Time and Trouble

No waiting to register . . . your Conference and hotel registrations will be made in advance . . . card, badge, program and room key ready when you arrive—pay $10 Conference fee and go directly to your room or to first meeting.

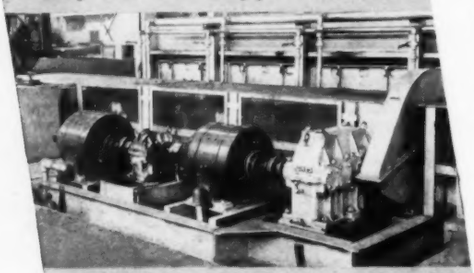
18th Annual **CONFERENCE** *and Exposition*
National **INDUSTRIAL ADVERTISERS** *Association*
SEPT. 18, 19, 20 . . . DETROIT . . . HOTEL STATLER

KEEP GOING with Jones

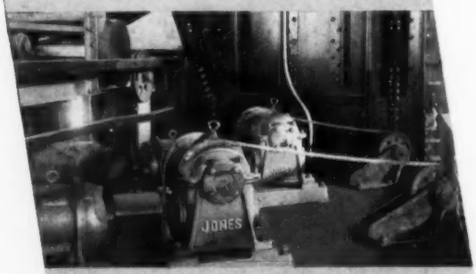
Jones Herringbone Speed Reducer driving steel tube mill draw bench. Gear casings removed to show proportions of spur gear drive to head shaft.



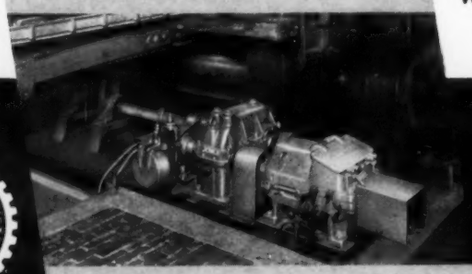
Jones Worm Gear Speed Reducer operating cover of warming pit in steel mill.



Jones Herringbone Reducers operating furnace in steel mill. Drive consists of two motors with single type and double type reducers coupled in series in order to obtain two widely varying speeds.



Two of a battery of 10 Jones Worm Gear Door Hoists for operating open hearth furnace doors.

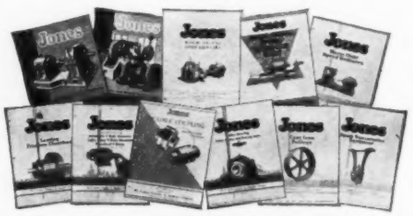


Jones Herringbone Reducer operating sheet mill tilting drive on feeder table.

IN every phase of the steel business today, whether it is production or fabrication, the cry is "keep going". Whether it's for the augmented industrial needs or whether for the speeded up requirements of national defense, wheels must be kept turning.

The Jones organization too, is busy manufacturing the various types of speed reducers and other transmission products that are so essential for drives in every type of plant—drives that are so necessary in maintaining peak production.

We picture here some typical Jones drives that have seen years of service in the steel industry. They have been called upon to take a lot of punishment and they will stand the gaff for a good many years to come.

Listed below are the Jones catalogs that present detailed information on Jones transmission products and their applications. These catalogs will help you with the solution of almost any drive problem that may come up. We shall be pleased to send you any, or all, of them.

ANY, OR ALL, OF THESE JONES CATALOGS WILL BE SENT ON REQUEST

No. 70—Jones Herringbone Speed Reducers
No. 71—Jones Cut and Molded Tooth Gears
No. 75—Jones Worm Helical Speed Reducers
No. 55—Jones Spur Gear Speed Reducer Units
No. 68—Jones Worm Gear Speed Reducers
No. 60—Jones Lemley Friction Clutches
No. 58B and 76—Jones V-Belt Sheaves
No. 78—Jones Flexible Couplings
No. 56—Jones Roller Bearing Pillow Blocks
No. 69—Jones Cast Iron Pulleys
No. 61—Jones Power Transmission Equipment

W. A. JONES FOUNDRY & MACHINE CO.
4431 ROOSEVELT ROAD, CHICAGO, ILLINOIS

IN THE SERVICE OF INDUSTRY JONES

Jones

HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS
CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES
ANTI-FRICTION PILLOW BLOCKS • PULLEYS
FRICTION CLUTCHES • TRANSMISSION APPLIANCES

REDUCED MAINTENANCE

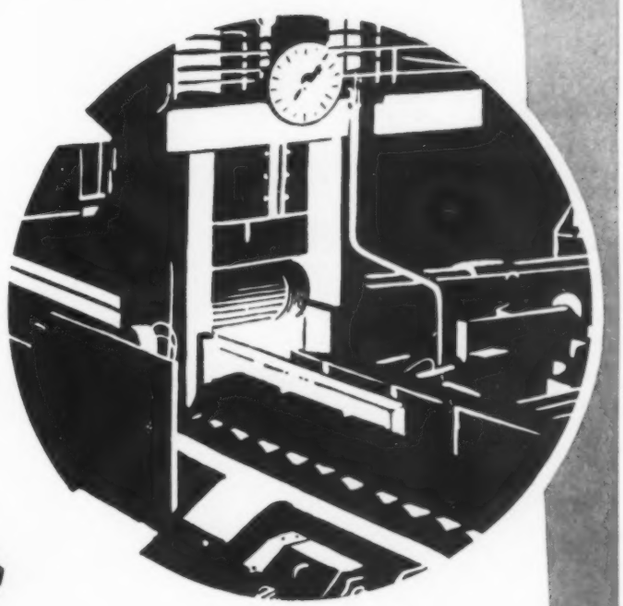
ON COMMUTATING EQUIPMENT

with

NATIONAL

TRADE-MARK

CARBON BRUSHES

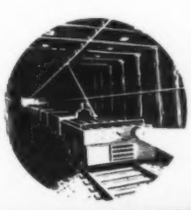


● Minimum maintenance expense on commutating equipment is obtained by selecting brush grades having properties adapted to machine characteristics and service conditions.

"National" Carbon Brushes provide a well balanced assortment of grades: carbon, graphite, electro-graphitic and metal-graphite. There is a grade of "National" brushes for every type of machine and all classes of service. Our conveniently located representatives will gladly co-operate with you in effecting reduced maintenance expense through the selection of "National" grades specifically adapted to your equipment and service.

WRITE or WIRE to our nearest Branch Sales Office.

To offset the effects of vibration specify **RESILIENT PRESSURE PADS** on holder end of brushes.



UNIT OF UNION CARBIDE AND CARBON CORPORATION

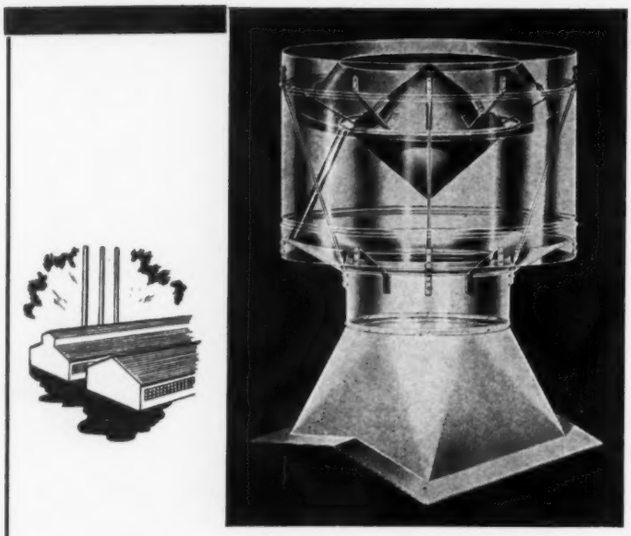
UCC

NATIONAL CARBON COMPANY, INC.

CARBON SALES DIVISION . . CLEVELAND, OHIO

GENERAL OFFICES: 30 East 42nd Street, New York, N. Y.

BRANCH SALES OFFICES
NEW YORK
PITTSBURGH
CHICAGO
ST. LOUIS
SAN FRANCISCO



BURT

Free-Flow Gravity

VENTILATORS

at the Indiana Harbor Plant

YOUNGSTOWN SHEET & TUBE CO.

The illustration above shows the interior construction of the Burt Free-Flow Ventilators installed on the Indiana Harbor Plant. These were specially designed for heavy-duty service in steel mills and other large industrial plants where a super-capacity, trouble-free type of roof ventilator is required. Rugged, efficient and dependable, Burt Free-Flow Gravity Ventilators have proved their value under the most exacting conditions.

The Free-Flow Gravity Ventilator, together with its companion units, the Free-Flow Fan and the Monovent Continuous Ridge Ventilator, presents the correct solution of your ventilating problems. Detailed data, job references and engineering assistance will be furnished promptly.

THE BURT MFG. CO.
ROOF VENTILATORS • OIL FILTERS
EXHAUST HEADS
950 SOUTH HIGH STREET AKRON, OHIO

SEND FOR CATALOGS
•
Burt Engineers are glad to help on plans

If it's
OIL IMMERSED PUSH BUTTONS—

ROWAN HAS THE MOST COMPLETE LINE AVAILABLE

Bulletins 3961 and 3962 show the many circuit arrangements available in the standard and Class 1, Group D, push button stations. The data contained in these bulletins simplifies the selection of push buttons for various applications. Copies on request.

ROWAN CONTROL
THE ROWAN CONTROLLER CO., BALTIMORE, MD

OIL-IMMERSED FLOAT SWITCH
for maintaining a high or low liquid level

The Rowan Type 600-1 rod operated Float Switch is designed for either tank or sump operation. The entire operating mechanism is oil immersed, making it particularly suited for use in corrosive atmospheres. It is of the quick acting make and break type and is not affected by oscillating liquids.

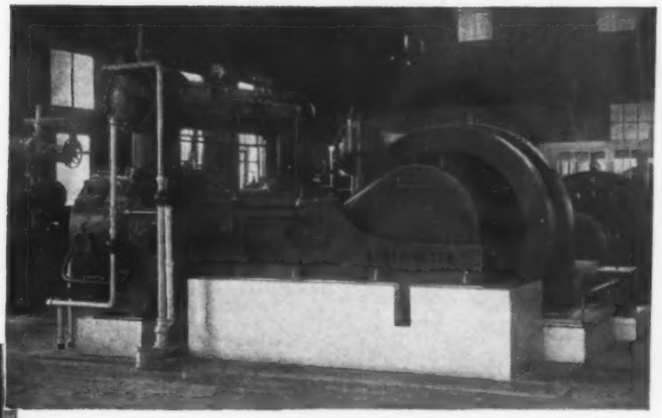
The Type 600-1 switch has a liberal rating and can be used either as a pilot switch or for direct operation of fractional horsepower motors.

Bulletin 3911 on request.

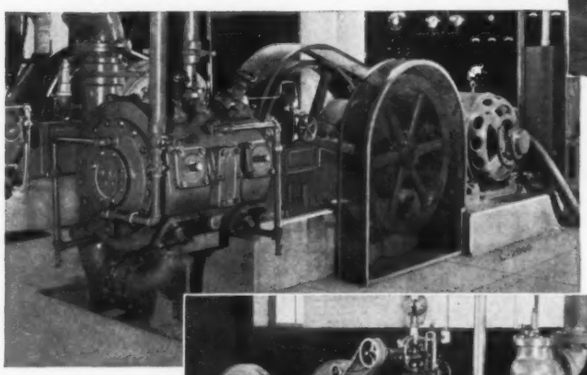
Type 600-1 switch designed to conform with the manufacturer's interpretation of the Underwriters' Laboratories, Inc. standards but not listed or tested by Underwriters' Laboratories, Inc.

THE ROWAN CONTROLLER CO.
BALTIMORE MARYLAND

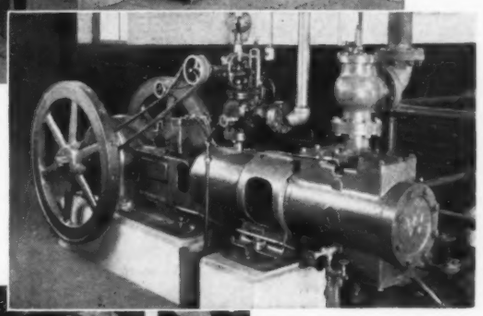
WORTHINGTON AIR and GAS COMPRESSORS



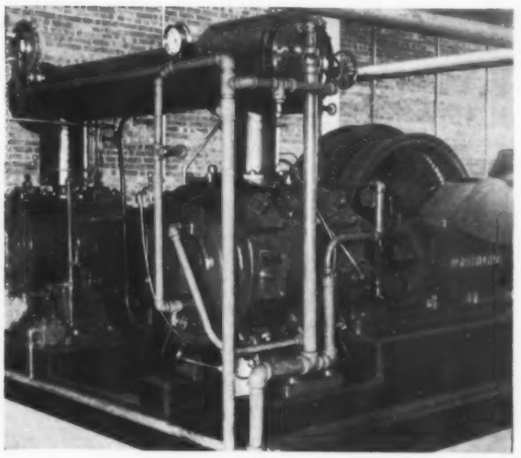
Two-stage air compressor, driven by synchronous motor, recently installed in a large steel foundry



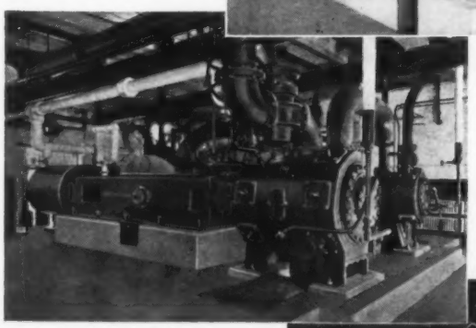
Single-stage air compressor, motor-driven through Worthington Multi-V-Belt drive, supplying air to a pneumatic tube system



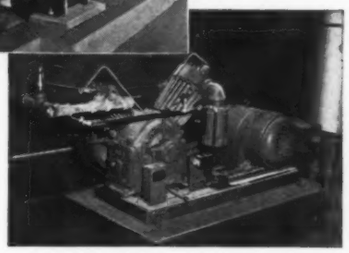
Single-stage steam-driven air compressor . . . in the service of a Western railroad



Two-stage air compressor, synchronous-motor-driven, in a large metal products plant



Two-stage steam-driven compressor . . . in a prominent Southern oil refinery.



Two-stage angle type air compressor . . . for many medium air supply applications

are serving important users in every industry

FOR any condition . . . from that of the smallest shop to the largest industrial plant . . . there is a Worthington compressor unit to meet it correctly . . . without bias or compromise in its selection.

An UNFAILING COMPRESSED AIR SUPPLY
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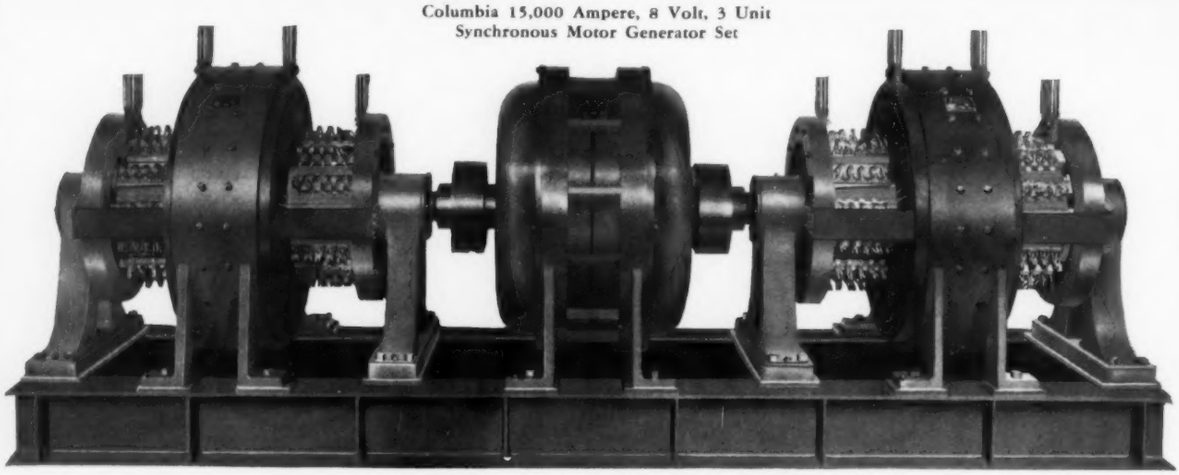

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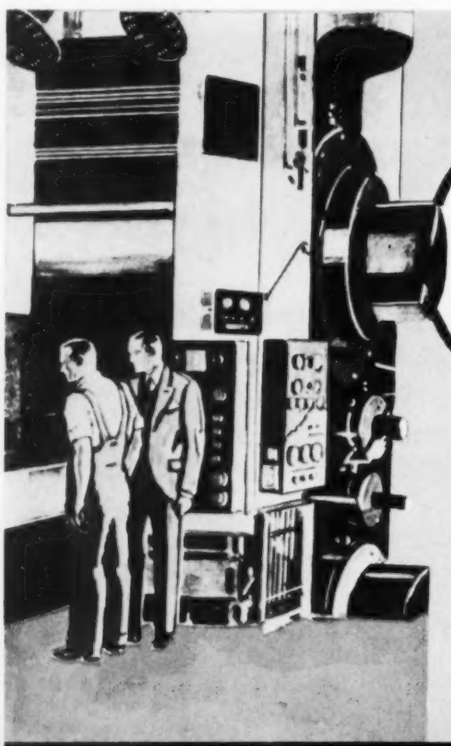

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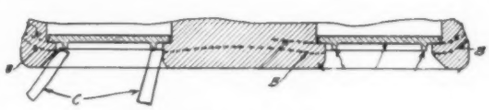

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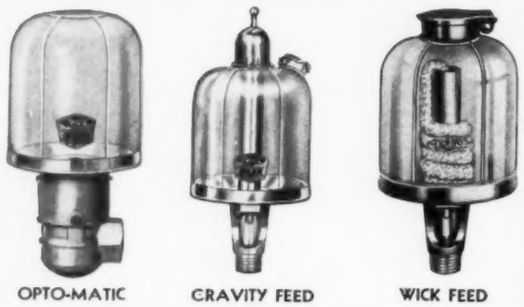

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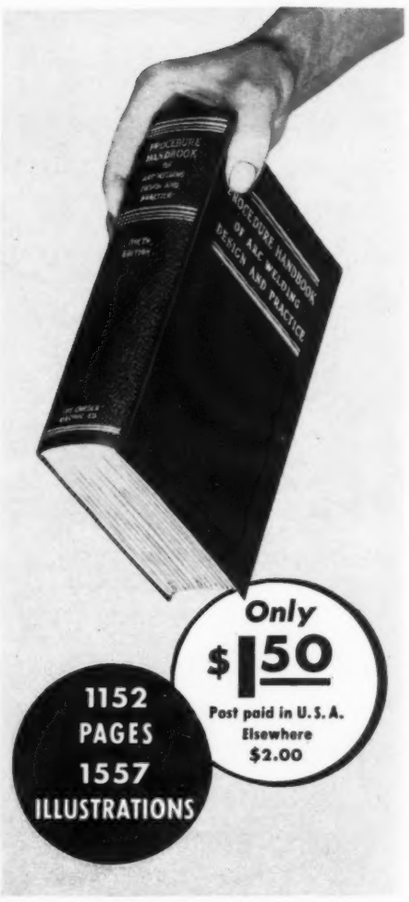

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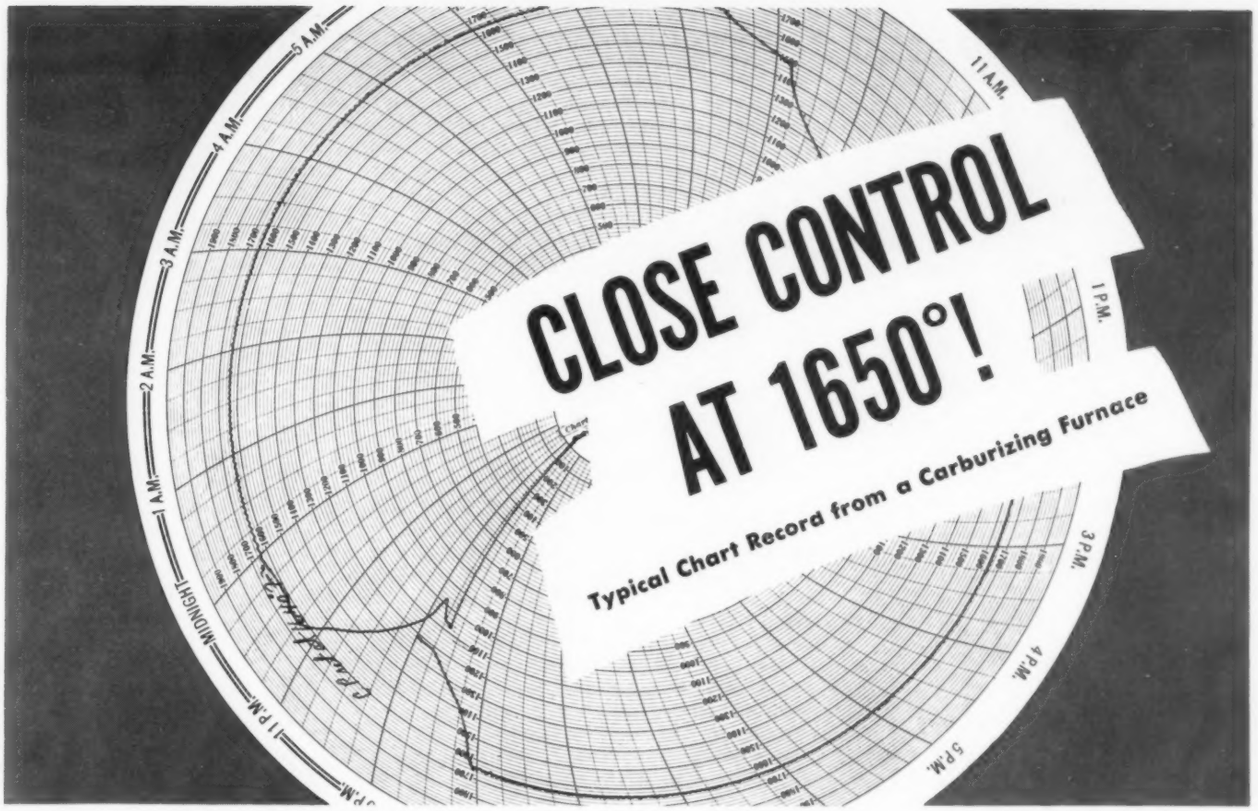

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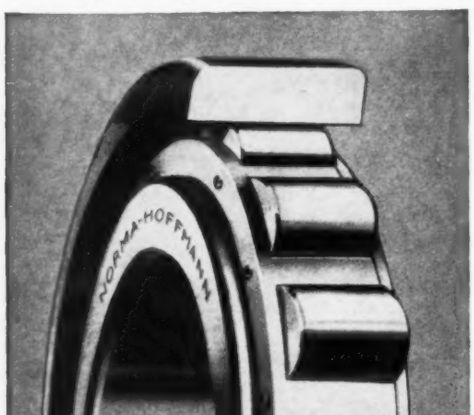

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